
**Endangered Species Act – Section 7 Consultation
Biological Opinion and Incidental Take Statement**

Agency: National Marine Fisheries Service
Alaska Region Sustainable Fisheries Division

Activities Considered: Authorization of Bering Sea/Aleutian Islands groundfish fisheries based on the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish; and

Authorization of Gulf of Alaska groundfish fisheries based on the Fishery Management Plan for Groundfish of the Gulf of Alaska.

Consultation By: National Marine Fisheries Service
Protected Resources Division

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

1	PURPOSE AND CONSULTATION HISTORY	13
1.1	Consultation History	14
2	DESCRIPTION OF THE PROPOSED ACTIONS	16
2.1	Overview of the MSA	16
2.2	The FMPs	18
2.3	Overview of Management Agencies, the Council, and the Fishery Management Process	18
2.3.1	NMFS	18
2.3.2	U.S. Coast Guard	19
2.3.3	State of Alaska	19
2.3.4	North Pacific Fishery Management Council	20
2.3.5	Fishery Management Process	20
2.4	Annual Fisheries Cycle	22
2.4.1	Stock assessment	22
2.4.2	Setting the TAC	29
2.4.3	Fisheries Removal	40
2.4.4	Monitoring and Evaluation of Fisheries Catch	47
3	ACTION AREA	58
3.1	Critical Habitat in the Action Area	60
4	STATUS OF SPECIES	63
4.1	Blue Whale	64
4.1.1	Species description and distribution	64
4.1.2	Life history information	65
4.1.3	Listing status	65
4.1.4	Population status and trends	66
4.1.5	Impacts of human activity on the species	66
4.2	Bowhead Whale	67
4.2.1	Species description and distribution	67
4.2.2	Life history information	67
4.2.3	Listing status	68
4.2.4	Population status and trends	68
4.2.5	Impacts of human activity on the species	69
4.3	Fin Whale	69
4.3.1	Species description and distribution	69
4.3.2	Life history information	70
4.3.3	Listing status	70
4.3.4	Population status and trends	70
4.3.5	Impacts of human activity on this species	71

4.4	Humpback Whale	71
4.4.1	Species description and distribution	71
4.4.2	Life history information	72
4.4.3	Listing status	72
4.4.4	Population status and trends	72
4.4.5	Impacts of human activity on the species	73
4.5	Right Whale	74
4.5.1	Species description and distribution	74
4.5.2	Life history information	74
4.5.3	Listing status	75
4.5.4	Population status and trends	75
4.5.5	Impacts of human activity on the species	75
4.6	Sei Whale	76
4.6.1	Species description and distribution	76
4.6.2	Life history information	76
4.6.3	Listing status	77
4.6.4	Population status and trends	77
4.6.5	Impacts of human activity on the species	77
4.7	Sperm Whale	78
4.7.1	Species description and distribution	78
4.7.2	Life history information	78
4.7.3	Listing status	79
4.7.4	Population status and trends	79
4.7.5	Impacts of human activity on the species	79
4.8	Steller Sea Lion	79
4.8.1	Species description	79
4.8.2	Distribution	80
4.8.3	Reproduction	80
4.8.4	Survival	83
4.8.5	Age distribution	83
4.8.6	Steller sea lion foraging behavior	84
4.8.7	Physiology	96
4.8.8	Natural predators	99
4.8.9	Natural competitors	100
4.8.10	Disease	100
4.8.11	Population distribution	101
4.8.12	Population Status and Trends	102
4.8.13	Population Variability and Stability	103
4.8.14	Population Projections	104
4.8.15	Listing status	105
4.9	Chinook Salmon	105
4.9.1	Puget sound chinook salmon	107
4.9.2	Lower Columbia River chinook salmon	109
4.9.3	Upper Columbia River spring chinook salmon	110
4.9.4	Upper Willamette River Chinook Salmon	111
4.9.5	Snake River Spring/summer Chinook Salmon	112
4.9.6	Snake River fall chinook salmon	113
4.10	Snake River Sockeye Salmon	115

4.10.1	Species description and distribution	115
4.10.2	Life history information	115
4.10.3	Listing status	116
4.10.4	Population status and trends	116
4.10.5	Impacts of human activity on the species	116
4.11	Steelhead	119
4.11.1	Upper Columbia River Steelhead	120
4.11.2	Middle Columbia River Steelhead	121
4.11.3	Lower Columbia River Steelhead	122
4.11.4	Upper Willamette River steelhead	122
4.11.5	Snake River Basin Steelhead	123
4.12	Leatherback Sea Turtle	124
4.12.1	Species Description and Distribution	124
4.12.2	Life History Information	125
4.12.3	Listing status	125
4.12.4	Population status and trends	125
4.12.5	Impacts of human activity on the species	126
4.13	Steller Sea lion Critical Habitat	127
4.13.1	Establishment of Steller sea lion critical habitat	127
4.13.2	Physical and biological features of Steller sea lion critical habitat	128
5	ENVIRONMENTAL BASELINE	131
5.1	Environmental Change in the Action Area	131
5.1.1	Natural climatic variability and the regime shift hypothesis	131
5.1.2	Impacts on Biological Productivity and Animal Populations	132
5.1.2	Possible changes in the carrying capacity of the Bering Sea and Gulf of Alaska	137
5.2	Impacts of Killer Whale Predation on Natural Mortality of Listed Species	138
5.2.1	Steller sea lions	138
5.3	Impact to Water Quality Due to Human Population Growth in the Action Area	141
5.4	Historical Harvest of Currently Listed Species	142
5.4.1	Subsistence harvests of listed species	142
5.4.2	Commercial harvest of listed species	143
5.4.3	Aggregate Known Mortality of Steller Sea Lions in Alaska	147
5.5	Impacts of Commercial Fisheries Within the Action Area	147
5.5.1	Impacts of early commercial fisheries from the 1800s to the 1950s	148
5.5.2	Impacts of large scale growth of commercial fisheries from the 1950s to the 1970s	150
5.5.3	Impacts of commercial fisheries within the action area from the 1970s to the present	153
5.5.4	Impacts of Alaska State managed fisheries	166
5.5.5	Direct effects of commercial fisheries on listed species	174
5.5.6	Indirect effects of commercial fisheries on listed species	181
5.6	Impacts of Oil and Gas Development	190
5.7	Impacts of Research and Other Activities	190
5.8	Summary of Conservation Measures Taken Under the MMPA and the ESA for Listed Species	191
5.8.1	Steller sea lions	191

5.8.2	Salmon	194
6	EFFECTS OF THE FEDERAL ACTION	195
6.1	Analytical Approach	195
6.2	Background Information	196
6.2.1	Definitions	196
6.2.2	The fundamental characteristics of groundfish fisheries	198
6.2.3	Other applicable law which effect the FMPs and their consequences	199
6.3	Description of the FMP Process for Determining the Annual Groundfish Catch	200
6.3.1	Biological information – groundfish surveys	200
6.3.2	Stock assessment	203
6.3.3	Setting the catch specifications (TAC)	209
6.3.4	Implementation of the fishery	213
6.3.5	Monitoring	221
6.4	Direct Effects of the FMPs on Listed Species and their Environment	223
6.4.1	Effects of the global fishery exploitation strategy on listed species	223
6.4.2	Direct effects of fishing on short term/local prey availability	227
6.4.3	Effects of global, regional, and local groundfish exploitation: Steller sea lion case study	233
6.5	Indirect Effects of the FMPs on Listed Species and their Environment	240
6.5.1	Effects on water quality	241
6.5.2	Effects on benthic habitat	242
6.5.3	Effects on the ecosystem	243
6.6	Response of Threatened and Endangered Species	250
6.6.1	Steller sea lions	251
6.6.2	Critical habitat for Steller sea lions	254
6.6.3	Summary of Effects on Steller Sea Lions	258
6.6.4	Large cetaceans	260
6.6.5	Pacific salmon	261
6.6.6	Leatherback Turtles	261
7	CUMULATIVE EFFECTS	263
7.1	Direct Effects	263
7.2	Indirect Effects	263
7.2.1	Alaska State commercial fisheries	263
7.2.2	Alaska State sport fisheries	265
7.2.3	Alaska State subsistence harvest of groundfish in the GOA and BSAI	265
7.2.4	Alaska State oil and gas leasing	266
7.2.5	Alaska State population	266
8	CONCLUSIONS	268
9	REASONABLE AND PRUDENT ALTERNATIVE	271
9.1	Principles for the Reasonable and Prudent Alternative	271
9.2	Reasonable and Prudent Alternative	272
9.2.1	Global Control Rule	273
9.2.2	Closure areas	273
9.2.3	Temporal apportionment of TACs	274

9.2.4	Spatial apportionment of TAC	274
9.2.5	Monitoring	275
9.2.6	Overview of the conservation impacts of the RPA	276
9.3	Implementation of the RPA	279
9.3.1	Description of Measures Required in the EBS, AI and GOA	279
9.3.2	Specifics and Examples of the RPA in EBS	282
9.3.3	Specifics and Examples of the RPA in the Gulf of Alaska	283
9.3.4	Specifics and Examples of the RPA in the AI	286
9.4	How the RPA Avoids Jeopardy and Adverse Modification	288
9.4.1	The approach used	288
9.4.2	The Global Control Rule	291
9.4.3	Avoidance of niche overlap	292
9.4.4	Dispersing harvest under the RPA	293
9.5	Monitoring the effects of the action as modified by the RPA	293
9.5.1	Design detail	294
9.5.2	Assumptions	294
9.5.3	Interpreting results of the monitoring project	294
9.6	Risk Analysis	299
10	INCIDENTAL TAKE STATEMENT	301
11	CONSERVATION RECOMMENDATIONS	304
11.1	Comprehensive Assessment Process	304
11.2	Minimizing the Ecosystem Effects of the “Race for Fish”	305
11.3	Further Exploration and Reduction of Uncertainty	306
11.4	Further Research on the Extent and Nature of Steller Sea Lion Foraging Habitat ...	306
11.5	Incidental Take Statement for Alaska State Fisheries	306
11.6	Information on Listed Salmon Species	306
11.7	Establish a NMFS Steller Sea Lion Team	307
11.8	Initiate Scientific and Public Review of the Biological Opinion	307
11.9	Monitoring Program	308
11.10	Recovery Plan	308
12	REINITIATION - CLOSING STATEMENT	309
13	LITERATURE CITED	310

THE FOLLOWING ARE ATTACHED

INDEX OF ABBREVIATIONS

APPENDICES 1-4

TABLES

FIGURES

EXECUTIVE SUMMARY

In compliance with section 7 of the Endangered Species Act (ESA), the National Marine Fisheries Service (NMFS) has completed this biological opinion consulting on the authorization of groundfish fisheries in the Bering Sea and Aleutian Islands region (BSAI) under the Fishery Management Plan (FMP) for the BSAI Groundfish, and the authorization of groundfish fisheries in the Gulf of Alaska (GOA) under the FMP for Groundfish of the GOA. This opinion is comprehensive in scope and considers the fisheries and the overall management framework established by the respective FMPs to determine whether that framework contains necessary measures to ensure the protection of listed species and critical habitat. The opinion determines whether the BSAI or GOA groundfish fisheries, as implemented under the respective FMPs, jeopardize the continued existence of listed species in the areas affected by the fisheries (i.e., the action areas) or adversely modify critical habitat of such species.

Action Area

The action area consists of “all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action” (50 CFR 402.02(d)). As such, the action area for the Federally managed BSAI groundfish fisheries covers all of the Bering Sea under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands west of 170°W longitude to the border of the U.S. Exclusive Economic Zone. The action area covered by the GOA FMP applies to the U.S. Exclusive Economic Zone of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance. The area encompasses sites that are directly affected by fishing, as well as sites likely to be indirectly affected by the removal of fish at nearby sites. The action area would also, necessarily, include those state waters that are encompassed by critical habitat for Steller sea lions.

The action area includes the Alaska range of both the endangered western and threatened eastern populations of the Steller sea lion. However, the effects of the Federal FMPs on Steller sea lions generally occur within the range of the western population. Therefore, this consultation focuses primarily on areas west of 144° W longitude (the defined boundary of the western population of Steller sea lions).

NMFS has determined that the action being considered in this biological opinion may affect 22 species listed under the ESA, including 7 species of endangered whales, the two distinct populations of Steller sea lions, twelve evolutionarily significant units (ESU) of Pacific salmonids and one species of endangered sea turtle. The action area also includes 4 species of endangered or threatened seabirds, and 1 species of marine mammal, the northern sea otter, that has been proposed as a candidate species under the ESA.

Environmental Baseline

The environmental baseline for the biological opinion must include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone consultations, and the impact of contemporaneous State or private actions (50 CFR §402.02). The environmental baseline for this biological opinion includes the effects of a wide variety of human activities and natural phenomena that

may affect the survival and recovery of threatened and endangered species in the action area. The opinion recognizes that such phenomena and activities have contributed to the current status of populations of those listed species. While some may have occurred in the past but no longer affect these species, others may continue to affect populations of listed species in the study area.

The environmental baseline for this action includes fisheries and other FMP-associated activities that are occurring, and that have occurred prior to January 2000. Other human-related activities discussed that may affect, or have affected, the baseline include the impacts of human growth on the action area and the effects of commercial and subsistence harvests of marine mammals. Alaska managed commercial fisheries are also addressed. Those fisheries and their effects on listed species are expected to continue in the action area and into the future. Herring and salmon are fisheries that are managed entirely by the State of Alaska, or, in the case of pollock and Pacific cod, only a percentage of the fishery is managed by State authority, and are species found year-round in the diet of Steller sea lions.

The environmental baseline also discusses the potential effects of the environmental changes on the carrying capacity of the action area over the past several decades, including the relationship between the dietary needs of Steller sea lions, the regime shift hypothesis, and massive population declines in recent decades. The opinion concludes that it is highly unlikely that natural environmental change has been the sole underlying cause for the decline of Steller sea lions.

The environmental baseline attempts to bring together all of the estimated mortalities of Steller sea lions and a synthesis of the significance of those takes. The best available scientific information on the magnitude and likely impacts of Orca predation on listed species in the action area are analyzed. Other factors, such as disease, ecological effects of commercial whaling through the 1970s, and pollutants, while not entirely excluded as contributing factors, have been considered, but are given lesser importance in explaining the observed pattern of declines.

Effects of Actions

The scope of the “effects of actions” analysis is intended to be comprehensive. As such, the opinion is broad and examines a range of activities conducted pursuant to the FMPs including the manner in which the total allowable catch levels are set, the process that leads to the setting of these levels, the amount of prey biomass taken from sea lion critical habitat. The effects of other activities that are interrelated or interdependent are also analyzed. Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The first part of the effects analysis is a description of fishery management as practiced under the FMPs, including an explanation of how ecosystem issues are considered. Particularly important sources of potential ecosystem effects are highlighted in subsequent sections. The second part of the effects analysis focuses on the current exploitation strategy and its potential relevance, both past and present, in shaping changes in the abundance and population structure of groundfish stocks. The present fishery management regime’s maximum target fishing reference point of $B_{40\%}$ is used as an example to illustrate the potential direction and intensity of direct effects.

The third part of the effects analysis reviews the annual fishery cycle, from surveys through the establishment of Total Allowable Catch (TAC) levels. The effects are evaluated specific to the major

stages of the cycle and to explore whether effects can be compounded through subsequent steps in the cycle. Finally, in the fourth part of the effects analysis, the FMPs and their management tools and policies are examined as guiding documents for management of the fisheries and protection of the associated ecosystems. This part also addresses the fisheries as they are prosecuted under the FMPs.

Cumulative Effects

Cumulative effects include the effects of *future* State, tribal, local, or private actions that are reasonably certain to occur in the action area. The State groundfish fisheries are generally smaller than the federal groundfish fisheries but are expected to have marginally more impacts (because of location) on listed species with respect to competition for prey and long term ecosystem impacts. The crab fishery is one of the biggest fisheries managed by the state. However, this fishery is not likely to directly compete for prey with either Steller sea lions or other listed species. Herring, salmon, Pacific cod, pollock, squid, and octopus are items found year-round in the diet of Steller sea lions. Species such as salmon and herring occur much more frequently in the summer as determined by analyses of Steller sea lion prey habits from 1990-1998.

Perhaps the most important interaction between state fisheries and listed species may arise from the pattern of localized removals of spawners. Although the patterns are generally similar from one fishery to the next, the sheer number of distinct fisheries makes it difficult to describe them individually. Likewise, each fishery is distinctly different in either the number of boats, gear used, time of year, length of season, and fish species. Therefore, we present the herring fishery as an example of this type of interaction to demonstrate some of the competitive interactions that may occur.

The impacts of some of the State fisheries on Steller sea lions and, in some cases, humpback whales would be similar to those of the Federal fisheries: cascade effects and competition. Steller sea lions and some of the State fisheries actively demand a common resource and the fisheries reduce the availability of that common resource to Steller sea lions while they satisfy their demand for fish. The State groundfish fisheries may reduce the abundance or alter the distribution of several prey species of listed species.

After reviewing the current status of each listed species in the action area, the environmental baseline for the action area, the effects of the FMPs for Alaska Groundfish in the BSAI and GOA, and the cumulative effects of the federal action, NMFS has determined that the FMPs are not likely to jeopardize the continued existence of any listed species in the action area except for the endangered western population of Steller sea lions. In addition, after reviewing the current status of critical habitat that has been designated for Steller sea lions, the environmental baseline for the action area, the FMPs for Alaska Groundfish in the BSAI and GOA, and the cumulative effects, it is NMFS' biological opinion that the FMPs are likely to adversely modify this critical habitat designated for Steller sea lions.

Reasonable and Prudent Alternative

Based on the effects discussion and NMFS determination that fishing activity under the FMPs are likely to jeopardize the continued existence of the western population of Steller sea lions and are likely to adversely modify their designated critical habitat, NMFS has developed a reasonable and prudent alternative (RPA) with multiple components for the groundfish fisheries in the BSAI and GOA. The fisheries effects that give rise to these determinations include both large scale removals of Steller sea lion forage over time, and the potential for reduced availability of prey on the fishing grounds at scales of

importance to individual foraging Steller sea lions.

The first RPA element addresses the harvest strategy for fish removal at the global or FMP level. This RPA requires the adoption of a new harvest control rule that would decrease the likelihood that the fished biomass for pollock, Pacific cod and Atka mackerel would drop below $B_{40\%}$. ***The global control rule is a revised, more precautionary fishing strategy ($F_{40\%}$ adjustment procedure) for principal prey of Steller sea lions taken by the groundfish fisheries in the BSAI and GOA (pollock, Pacific cod and Atka mackerel) than that which currently exists under the FMP.*** The effect of using the global control rule is increased likelihood that the stock is maintained at or above the target stock size by reducing the exploitation rate at low stock sizes.

Other RPA elements completely protect sea lions from groundfish fisheries at global and regional scales, and in both temporal and spatial dimensions. The other RPA elements reflect a hierarchy of NMFS concerns about the effects of the groundfish fisheries on Steller sea lions. Those concerns are greatest with respect to critical habitat areas around rookeries and major haulouts, and in special foraging areas designated as critical habitat, and less for areas outside of critical habitat where take levels are not considered to be at a level that would jeopardize Steller sea lions. ***Significant interactions between sea lions and the fisheries for pollock, Pacific cod and Atka mackerel have been eliminated in critical habitat between November 1 and January 19, or 22% of the year.*** This level of partitioning is necessary in this period because sea lions at this time are considered extremely sensitive to prey availability. Because fisheries are restricted to the remaining 78% of the year, dispersive actions taken at finer temporal and spatial scales are also necessary to avoid jeopardy and adverse modification. ***The RPA extends 3 nautical mile (nm) protective zones around rookeries to all haulouts. In the GOA, EBS and AI, a total of 139 no-fishing zones (note: the rookeries are already no-entry zones) are established that will partition all pups and non-pups from disturbances associated with vessel traffic and fishing in close proximity to important terrestrial breeding and resting habitat. The RPA closes many rookeries and haulouts out to 20 nm to directed fishing for pollock, Pacific cod and Atka mackerel.*** This second spatial partitioning element excludes all fisheries for pollock, Pacific cod, and Atka mackerel from approximately 63% of critical habitat in the GOA, EBS, and Aleutian Islands. These measures significantly increase the amount of critical habitat protected from directed fishing for Steller sea lion prey, greatly reduces the number of potential takes of Steller sea lions through competition for a prey base inside critical habitat, completely protects all pups and non-pups on rookeries and haulouts out to 3 nm from the effects of fishing activity, and greatly reduces the interactions between fisheries and sea lions during winter months.

Fisheries occurring in the remaining 34% of critical habitat and the areas outside critical habitat require further dispersive actions to avoid jeopardy and adverse modification. The temporal concentration of fisheries for pollock, Pacific cod and Atka mackerel may result in high local harvest rates that may reduce the quality of habitat by modifying prey availability. The RPA establishes the following measures to disperse fishing effort at regional and local scales and to reduce the effects of groundfish fisheries on prey availability for sea lions to negligible or background levels.

The RPA separates the fisheries into four seasonal limits inside critical habitat, and two seasonal releases outside of critical habitat, and disperses fishing effort throughout the open portion of the year, January 20-October 31. Season start dates are spaced evenly throughout this period and portions of the TAC is allocated to each season. These actions reduce the proportion of pollock, Pacific cod and Atka mackerel taken inside critical habitat inside the GOA to less than 20% of the total catch. The measure also protects against excessive harvest rates that may rapidly deplete concentrations of prey inside critical

habitat. NMFS has concluded that a temporally dispersed fishery would not significantly harm the foraging success of Steller sea lions as the take would be reduced to a level that NMFS believes would not compromise them.

The spatial concentration of current fishing effort for pollock, Pacific cod and Atka mackerel may result in high local harvest rates that reduce the quality of habitat for foraging Steller sea lions. Fishing inside critical habitat may result in takes of Steller sea lions through adverse modification of habitat (i.e, prey availability). ***Therefore, this RPA reduces the percentage of pollock taken inside critical habitat from 80 to 42% in the GOA, from 45 to 14% in the EBS and from 74 to 2% in the AI compared to 1998. It also reduces the percentage of Pacific cod caught in critical habitat from 48 to 21% in the GOA, from 39 to 17% in the EBS and from 79 to 17% in the AI as compared to 1998. The RPA reduces the percentage of Atka mackerel caught inside critical habitat in the AI from 66 to 8 % as compared to 1998.***

Finally, the RPA is designed to close adequate portions of critical habitat to commercial fishing for the three primary prey species of groundfish, while imposing restrictions on fishing operations in areas open to fishing to avoid local depletion of prey resources for Steller sea lions. This approach of creating areas open and closed to fishing operations provides contrast between complete closures and restricting fishing areas within critical habitat and forms the basis for monitoring the RPA. Over the past decade the North Pacific Fisheries Management Council has noted the importance of assessing the efficacy of conservation measures intended to promote the recovery of the western population of Steller sea lions. To this end, NMFS has incorporated into its RPA a monitoring program that will allow for such an evaluation.

Incidental Take Statement and Conservation Recommendations

An Incidental Take Statement (ITS) specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which NMFS must comply in order to implement the reasonable and prudent measures and to be exempt from the prohibitions of section 9 of the ESA.

In addition to the RPA and ITS, conservation recommendations have been provided within this biological opinion. An example of one of the conservation recommendations that NMFS believes should be implemented is a more comprehensive stock assessment that would provide detailed information on groundfish stocks on spatial and temporal scales and to provide timely review of possible fishery interactions with listed species (and in the future on essential fish habitat). This would allow for better analysis of the possible impacts of target fisheries on listed species and the more proactive development of time/space harvest recommendations at the individual stock assessment level so that fishery interactions with listed species and essential fish habitat can be minimized.

The cumulative effect of the RPA elements contained in this biological opinion successfully removes jeopardy and avoid adverse modification of designated critical habitat. However, the State fisheries in Alaska, particularly those involving salmon, herring, and Pacific cod are likely to result in take of Steller sea lions and may require modification. As a conservation measure, NMFS also recommends that the State of Alaska request NMFS to assist in the development of a Habitat Conservation Plan (as authorized under section 10 of the ESA). This plan should be designed to mitigate adverse impacts on Steller sea lions and other listed species that might accrue from State managed fisheries. This plan should employ the same standards and principles as used in this biological opinion to prevent completion and minimize take between fisheries and listed species.

Conclusion

After analyzing the cumulative, direct and indirect effects of the Alaska groundfish fisheries on listed species, NMFS concludes that the fisheries do not jeopardize any listed species other than Steller sea lions. The biological opinion concludes that the fisheries do jeopardize Steller sea lions and adversely modify their critical habitat due to competition for prey and modification of their prey field. The three main species with which Steller sea lions compete for prey are pollock, Pacific cod, and Atka mackerel. The biological opinion provides a reasonable and prudent alternative to modify the fisheries in a way that avoids jeopardy and adverse modification.

1 PURPOSE AND CONSULTATION HISTORY

1 The Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.; ESA), provides the primary
2 legal framework for the conservation and recovery of species in danger of or threatened with extinction.
3 The purposes of the ESA include

4
5 “to provide a means whereby the ecosystems upon which endangered species and threatened
6 species depend may be conserved, [and] to provide a program for the conservation of such
7 endangered species and threatened species ...” (16 U.S.C. § 1531(b)).
8

9 Section 7(a)(2) of the ESA requires that each Federal agency shall insure that any action authorized,
10 funded, or carried out by such agency is not likely to jeopardize the continued existence of¹ any
11 endangered species or threatened species or result in the destruction or adverse modification² of critical
12 habitat of such species. When the action of a Federal agency may affect a protected species or its critical
13 habitat, that agency (i.e., the “action” agency) is required to consult with either the National Marine
14 Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the protected
15 species or critical habitat that may be affected. Section 7(b) of the ESA requires the Services to
16 summarize consultations in biological opinions that detail how actions may affect threatened or
17 endangered species and designated critical habitat.
18

19 This biological opinion is intended to fulfill NMFS obligations under section 7 of the ESA by consulting
20 on

- 21 (1) authorization of groundfish fisheries in the Bering Sea and Aleutian Island (BSAI) region
22 under the Fishery Management Plan (FMP) for the BSAI Groundfish, and
23
- 24 (2) authorization of groundfish fisheries in the Gulf of Alaska (GOA) under the FMP for
25 Groundfish of the GOA.³
26
27

28 This biological opinion is based on information provided in the 1998 Supplemental Environmental
29 Impact Statement (SEIS) on the groundfish total allowable catch (TAC) specifications, preliminary
30 analyses and discussions from the 2000 Draft Supplemental Environmental Impact Statement (DSEIS) on

¹ The term “jeopardize the continued existence of” means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of that species” (50 CFR § 402.02).

² The term “destruction or adverse modification” means “a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical” (50 CFR § 402.02).

³ Section 7 regulations allow a formal consultation to encompass a number of similar actions within a given geographic area or a segment of a comprehensive plan (50 CFR 402.14). Consistent with this regulatory provision and for purposes of efficiency, these two actions are summarized in a single biological opinion.

1 the Alaska groundfish FMPs, which is being prepared concurrent with this biological opinion, numerous
2 documents produced for and by the North Pacific Fishery Management Council (Council), previous
3 biological opinions and National Environmental Policy Act (NEPA) documents on council actions, and
4 published and unpublished sources of information on the biology and ecology of the action area and
5 listed species in the action area, the general history of fisheries in the action area, and fishery
6 management. A complete administrative record of this consultation is on file at NMFS Alaska Regional
7 Office [Consultation No. F/AKR/2000/00978].
8

9 Based on the ESA and implementing regulations, and the recent court findings with respect to previous
10 opinions, the scope of this opinion is intended to be comprehensive. The opinion considers not only the
11 fisheries themselves, but also the overall management framework as established under the respective
12 FMPs, to determine if that framework contains the necessary conservation and management measures to
13 insure the protection of listed species and critical habitat. The purpose of the opinion, then, is to
14 determine if the BSAI or GOA groundfish fisheries, as implemented under the respective FMPs, are
15 likely to jeopardize the continued existence of listed species in the areas affected by the fisheries (i.e., the
16 action areas) or are likely to destroy or adversely modify critical habitat of such species.
17

18 The opinion is based on an evaluation of the direct and indirect effects of the actions on listed species or
19 critical habitat, together with the effects of other activities that are interrelated or interdependent with
20 that action. These effects are considered in the context of an *Environmental Baseline* and *Cumulative*
21 *Effects*. The *Environmental Baseline* includes (1) the past and present impacts of all Federal, State,
22 Tribal, or private actions and other human activities in the action area, (2) the anticipated impacts of all
23 proposed Federal projects in the action areas that have already undergone section 7 consultation, and (3)
24 the impact of State or private actions which are contemporaneous with the consultation in process (50
25 CFR 402.02). *Cumulative Effects* are those effects of future State or private activities, not involving
26 Federal activities, that are reasonably certain to occur within the action area of these groundfish fisheries
27 (50 CFR 402.02).⁴
28

29 **1.1 Consultation History**

30
31 For the actions assessed in this document, the action agency is NMFS Office of Sustainable Fisheries
32 (OSF). For the protected species considered in this document, the consulting agency is NMFS Office of
33 Protected Resources (OPR). While the consultation is internal to NMFS, this opinion represents the
34 views of the consulting agency, OPR. NMFS has conducted multiple internal section 7 consultations on
35 the BSAI and GOA groundfish fisheries (Table 1.1). With respect to this opinion, the most recent and
36 relevant consultations are:
37

- 38 ! January 26, 1996 biological opinions on the FMPs for the BSAI Groundfish Fishery and the
39 GOA Groundfish Fishery, the proposed 1996 TAC Specifications and their effects on Steller Sea
40 Lions. These opinions concluded that the BSAI and GOA FMPs, fisheries, and harvests under
41 the proposed 1996 TAC specifications were not likely to jeopardize the continued existence of

⁴ The term “cumulative effects” is defined explicitly by the regulations implementing the ESA. That definition will be used throughout this document. However, in the context of management of the BSAI and GOA groundfish fisheries, the term “cumulative effects” has been used with a number of other meanings, including 1) long-term effects of a single fishery over time, 2) concurrent or combined effects of multiple fisheries at the same time (annual or longer time period) or in the same area, and 3) combined effects of fisheries and other human activities on any temporal or spatial scale. Each of these meanings will be addressed in the effects section, unless the issue under consideration falls within the ESA definition of cumulative effects.

1 Steller sea lions or to result in the destruction or adverse modification of their critical habitat.
2 With respect to these opinions, the agency also concluded that the reasons for the decline of
3 Steller sea lion populations and the possible role of the fisheries in the decline remain poorly
4 understood.
5

6 ! December 3, 1998 biological opinion on authorization of the BSAI Atka mackerel fishery, BSAI
7 pollock fishery, and GOA pollock fishery under their respective FMPs for the period from 1999
8 to 2002. The opinion concluded that the Atka mackerel fishery was not likely to jeopardize the
9 western population of Steller sea lion or adversely modify its critical habitat, but that the pollock
10 fisheries were likely to cause jeopardy and adverse modification. These conclusions and the
11 reasonable and prudent alternatives (RPAs) developed for the pollock fisheries were challenged
12 in court; the conclusions were upheld, but the RPAs were found arbitrary and capricious for lack
13 of sufficient information. The court ordered preparation of revised final reasonable and prudent
14 alternatives (RFRPAs), which were issued by NMFS on October 15, 1999 and were implemented
15 for the 2000 fisheries.
16

17 ! December 22, 1998 biological opinion on authorization of the BSAI and GOA groundfish
18 fisheries based on TAC specifications recommended by the Council for 1999. The opinion
19 concluded that based on the 1999 TAC specifications, the groundfish fisheries were not likely to
20 cause jeopardy or adverse modification for listed species or their critical habitat. The opinion
21 was also challenged in court and subsequently found to be arbitrary and capricious for failing to
22 include a sufficiently comprehensive analysis of the groundfish fisheries and their individual,
23 combined, and cumulative effects. Based on this finding, the court determined that NMFS was
24 out of compliance with the ESA (*GreenPeace v. National Marine Fisheries Service*, 80 F. Supp.
25 2d 1137 (WD. Wash. 2000).
26

27 ! December 23, 1999 biological opinion on authorization of the BSAI and GOA groundfish
28 fisheries based on TAC specifications recommended by the Council for 2000, and on
29 authorization of the fisheries based on statutes, regulations, and management measures to
30 implement the American Fisheries Act of 1998 (AFA). The opinion concluded that based on the
31 2000 TAC specifications and implementation of the AFA, the groundfish fisheries would not
32 cause jeopardy or adverse modification for listed species or their critical habitat. The opinion
33 has not been challenged in court, but was similar in scope to the December 22, 1998 opinion and
34 therefore may not provide the comprehensive analysis of the BSAI and GOA groundfish fisheries
35 required by the court.

2 DESCRIPTION OF THE PROPOSED ACTIONS

NMFS Office of Sustainable Fisheries (OSF), under the authority of the MSA, proposes to (1) authorize groundfish fisheries in the BSAI under the FMP for the BSAI Groundfish, and (2) authorize groundfish fisheries in the GOA under the FMP for Groundfish of the GOA. As stated in section 1, this opinion is comprehensive, including not only the fisheries covered under the FMPs, but an investigation of the overall management framework to determine if the framework contains the necessary conservation and management measures to ensure the protection of listed species and critical habitat.

The purpose of this chapter is to provide an overview of the MSA and the two FMPs for Alaska groundfish fisheries. The state and federal management agencies, the North Pacific Fishery Management Council (Council), and the fishery management process are described briefly. Then the annual management cycle is described, consisting of four main elements: stock assessment, setting the total allowable catch (TAC), implementation of the fisheries, and monitoring the catch and its effects.

2.1 Overview of the MSA

The MSA, passed in 1976, is the primary U.S. law dealing with the conservation and management of marine fisheries resources and fishing activities in Federal waters (those waters extending seaward from the edge of coastal state waters to the 200-mile limit). This area became known as the Exclusive Economic Zone (EEZ) in 1983.

The MSA created eight regional fishery management councils that are primarily charged with preparing fishery management plans and plan amendments that establish, once approved and implemented by NMFS, conservation and management programs for marine fisheries resources in the EEZ. The process for developing and implementing FMPs is described in 2.3.5.

To date, the councils have prepared, and NMFS has approved and implemented, 39 FMPs, some now with numerous amendments. These FMPs not only must comply with the MSA, but with the requirements of other Federal laws, such as NEPA, the Marine Mammal Protection Act (MMPA), the Regulatory Flexibility Act (RFA), and the ESA. The MSA contains provisions for taking into account the requirements of other laws, as well as the protection of marine ecosystems and the environment, some of which are contained in the definitions of “optimum yield” (OY) and “conservation and management”:

“The term “optimum”, with respect to the yield from a fishery, means the amount of fish which–

(A) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;

(B) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and

(C) in the case of an overfished fishery, provides for rebuilding to a level consistent with

1 producing the maximum sustainable yield of such fishery” (16 U.S.C. § 1802(3)(28))
2 (emphasis added).
3

4 The term “conservation and management” refers to all of the rules, regulations, conditions,
5 methods, and other measures (A) which are required to rebuild, restore, or maintain, and which
6 are useful in rebuilding, restoring, or maintaining, any fishery resources and the marine
7 environment; and (B) which are designed to assure that–
8

9 (i) a supply of food and other products may be taken, and that recreational benefits may
10 be obtained, on a continuing basis;
11

12 (ii) irreversible or long-term adverse effects on fishery resources and the marine
13 environment are avoided; and
14

15 (iii) there will be a multiplicity of options available with respect to future uses of these
16 resources” (16 U.S.C. § 1802(3)(5)) (emphasis added).
17

18 Section 301(a) of the MSA sets forth national standards for conservation and management with which
19 FMPs and regulations must be consistent. In addition, NMFS established 10 National Standard
20 Guidelines to assist in the development and review of FMPs, amendments, and regulations prepared by
21 the Councils and the Secretary (50 CFR 600 Subpart D). The National Standards are as follows.
22

23 *Standard 1.* Conservation and management measures shall prevent overfishing while achieving, on a
24 continuing basis, the OY from each fishery for the U.S. fishing industry.
25

26 *Standard 2.* Conservation and management measures shall be based on the best available scientific
27 information available.
28

29 *Standard 3.* To the extent practicable, an individual stock of fish shall be managed as a unit
30 throughout its range, and interrelated stocks of fish shall be managed as a unit or in close
31 coordination.
32

33 *Standard 4.* Conservation and management measures shall not discriminate between residents of
34 different states. If it becomes necessary to allocate or assign fishing privileges among
35 various U.S. fishermen, such allocation shall be: (1) fair and equitable to all such
36 fishermen; (2) reasonably calculated to promote conservation; and (3) carried out in such
37 manner that no particular individual, corporation, or other entity acquires an excessive
38 share of such privileges.
39

40 *Standard 5.* Conservation and management measures shall, where practicable, consider efficiency in
41 the utilization of fishery resources; except that no such measure shall have economic
42 allocation as its sole purpose.
43

44 *Standard 6.* Conservation and management measures shall take into account and allow for variations
45 among, and contingencies in, fisheries, fishery resources, and catches.
46

47 *Standard 7.* Conservation and management measures shall, where practicable, minimize costs and
48 avoid unnecessary duplication.

1 *Standard 8.* Conservation and management measures shall, consistent with the conservation
2 requirements of the Magnuson-Stevens Act (including the prevention of overfishing and
3 rebuilding of overfished stocks), taken into account the importance of fishery resources
4 to fishing communities in order to: (1) provide for the sustained participation of such
5 communities; and (2) to the extent practicable, minimize adverse economic impacts on
6 such communities.

7
8 *Standard 9.* Conservation and management measures shall, to the extent practicable: (1) minimize
9 bycatch; and (2) to the extent bycatch cannot be avoided, minimize the mortality of such
10 bycatch.

11
12 *Standard 10.* Conservation and management measures shall, to the extent practicable, promote the
13 safety of human life at sea.

14 15 **2.2 The FMPs**

16
17 For Alaska groundfish fisheries, the North Pacific Council developed, and NMFS has implemented, two
18 FMPs: one for groundfish fisheries in the BSAI area, and the other for the GOA area. The FMPs are the
19 overall guiding and planning documents for management of the groundfish fisheries in all their aspects.
20 They establish economic, social and biological goals that are consistent with the MSA and other laws and
21 include specific management approaches for achieving these goals. In addition to other measures, the
22 FMPs contain conservation and management measures designed to minimize the impacts of the fisheries
23 on listed species and their critical habitat. These measures are detailed later in this chapter, along with
24 other pertinent elements of the FMPs.

25
26 The BSAI FMP was approved by the Secretary of Commerce on October 27, 1979, and implemented by
27 regulations published on December 31, 1981 (46 FR 63295, corrected January 28, 1982, 47 FR 4083).
28 The GOA Groundfish FMP was approved by the Secretary on February 24, 1978, and implemented by
29 regulations published on November 14, 1978 (44 FR 52709). A brief overview of the contents of the
30 BSAI and GOA FMPs is provided in Appendix 1. Amendments to the plans are listed and briefly
31 described in Tables 2.1 (BSAI FMP) and 2.2 (GOA FMP).

32 33 **2.3 Overview of Management Agencies, the Council, and the Fishery Management Process**

34
35 The principal management agencies for the BSAI and GOA groundfish fisheries include NMFS, the U.S.
36 Coast Guard, the Alaska Department of Fish and Game (ADFG), and the Alaska Board of Fisheries.
37 Additional information will be provided in the description of the annual fisheries cycle later in this
38 section.

39 40 **2.3.1 NMFS**

41
42 The Alaska groundfish fisheries are managed under the authority of the Secretary of Commerce, who
43 delegates that authority through the Under Secretary and Administrator of NOAA to the Assistant
44 Administrator for Fisheries (that is, NMFS) and to the NMFS Regional Administrator, Alaska Region.
45 The Secretary may rescind this delegation at any time or for any management decision. NMFS is
46 responsible for the day-to-day management of the fisheries. The agency cooperates with the Council to
47 develop fishery policies, conducts rulemaking to implement FMP or regulatory amendments, conducts
48 analyses on the effects of the fisheries on the human environment, monitors the fisheries, and enforces

1 the rules and regulations implemented under the MSA and other applicable law.
2

3 NMFS also conducts research programs required to support the fisheries. For the Alaska groundfish
4 fisheries, research activities are conducted primarily by the Alaska Fisheries Science Center (AFSC).
5 Groundfish stocks in the BSAI and GOA are surveyed by the Resource Assessment and Conservation
6 Engineering (RACE) Division, stock assessment is conducted by the Resource Ecology and Fisheries
7 Management (REFM) Division, and research on marine mammals (including listed large cetaceans and
8 Steller sea lions) is conducted by the National Marine Mammal Laboratory (NMML), also a division of
9 the AFSC.

10
11 NMFS is also the principal management agency responsible for the recovery of a number of listed or
12 protected species in the BSAI and GOA regions. Those species are described in chapter 4.0 below.
13

14 **2.3.2 U.S. Coast Guard**

15
16 The U.S. Coast Guard provides services essential to the implementation of the fisheries, including
17 monitoring for safety and compliance with regulations, enforcement of such regulations, and field
18 assistance with research. The Coast Guard designates a non-voting representative to the Council to act as
19 an enforcement advisor, ensuring that conservation and management measures reflect the practical
20 realities of enforcement in the region. That member also advises Council members of the safety impacts
21 of proposed conservation and management measures.
22

23 The U.S. Coast Guard enforces compliance with fishery regulations and supports NOAA management
24 objectives. Using airborne and at-sea assets, the Coast Guard
25

- 26 • Prevents encroachment by foreign fishing vessels on the EEZ;
- 27 • Ensures compliance by U.S. fishermen with domestic living marine resource laws and
28 regulations within the EEZ;
- 29 • Enforces regulations implemented under laws such as the Marine Mammal Protection
30 Act and Endangered Species Act and protects threatened marine resources, and;
- 31 • Ensures compliance with international agreements for the management of living marine
32 resources on the high seas.
33

34 The Coast Guard also provides enforcement policy guidance to domestic lawmakers and regulators, and
35 to U.S. representatives in the international arena, ensuring national and international policy objectives are
36 achievable and enforceable.
37

38 **2.3.3 State of Alaska**

39
40 Since the MSA was passed in 1976, fisheries off Alaska have been managed by a combination of state
41 and federal agencies. Article VIII of the state constitution directs the Alaska legislature and executive
42 branch to manage state fisheries in such a way as to achieve maximum benefit to its people and
43 management of renewable resources on a sustained yield basis. The Alaska Department of Fish and
44 Game (ADFG) is the primary state fisheries management agency. ADFG also manages some groundfish
45 fisheries (especially cod) in state waters and lingcod and black rockfish fisheries throughout state waters
46 and the EEZ. The agency is generally responsible for management of fisheries for salmon, herring,
47 crabs, and other invertebrates. The agency monitors state fisheries, conducts fisheries research, assesses
48 stock condition, and determines appropriate harvest levels. The agency also has in-season emergency

1 authority to open and close fisheries. The Commercial Fisheries Entry Commission is a second state
2 agency that has authority to establish moratoria or limited-entry systems for state-managed fisheries. The
3 Alaska State Legislature created the Alaska Board of Fisheries to provide public access to the fishery
4 management process and to give direction to ADFG. The Board of Fisheries is responsible for
5 developing state fishery management plans, making allocative decisions, and promulgating regulations.
6 State fisheries will be considered below in the chapters on the Environmental Baseline (section 5) and
7 Cumulative Effects (section 7).
8

9 **2.3.4 North Pacific Fishery Management Council**

10 The Council, which is composed of 11 voting members, serves six main functions (16 U.S.C. 1852 §
11 302(h)(1-6)):
12

- 13 (1) prepares and submits FMPs for each fishery that requires conservation and management,
14 as well as amendments to each plan;
- 15 (2) prepares comments on certain applications for foreign fishing and on FMPs or
16 amendments prepared by the Secretary [of Commerce];
- 17 (3) conducts public hearings to allow public participation in the management process;
- 18 (4) submits to the Secretary reports that it deems necessary or that were requested by the
19 Secretary;
- 20 (5) for each fishery, reviews on a continuing basis the assessments and specifications
21 necessary to achieve optimum yield from, the capacity and extent to which United States
22 fish processors will process United States harvested fish from, and the total allowable
23 level of foreign fishing in, each fishery; and
- 24 (6) conducts any other activities required by the MSA or necessary and appropriate to the
25 foregoing functions.
26

27
28 In addition to the main Council body, the Council maintains four committees and panels. The Advisory
29 Panel consists primarily of representatives of the fishing industry and is intended to advise the Council
30 on any matters pertaining to the FMPs and amendments. The Scientific and Statistical Committee
31 consists of appointed scientists and is intended to assist in the development, collection, and evaluation of
32 statistical, biological, economic, social, and other scientific information necessary for development and
33 amendment of FMPs. The two remaining committees are Plan Teams for the BSAI and GOA groundfish
34 fisheries. These teams review stock assessment methods and results, and make recommendations on
35 harvest levels to the Council based on the status and trends of each stock and its tolerance for fishery
36 removal.
37

38 **2.3.5 Fishery Management Process**

39
40 General regulations governing U.S. fisheries appear at 50 CFR Part 600, and regulations specifically
41 governing the groundfish fisheries in the EEZ off Alaska appear at 50 CFR Part 679. The regulations
42 therein prescribe the existing regulatory framework for the federally managed groundfish fisheries off
43 Alaska. The following description of the management process is intended to be generic, illustrating the
44 process by which FMP amendments and regulatory amendments are developed. The setting of TACs
45 will be described below in the section on the annual cycle. The management processes for developing,
46 approving, and implementing FMP amendments and TAC-setting are illustrated in Figure 2.1.
47

48 FMPs, amendments to FMPs, and regulatory amendments are developed by the Council, submitted to the

1 Secretary of Commerce (Secretary) for review, and, if approved or partially approved, implemented by
2 federal regulations. Once approved, the regulations are put into effect and NMFS has responsibility for
3 day-to-day management of the fisheries. Enforcement of the regulations is carried out jointly by NMFS
4 and the U.S. Coast Guard. Disapproved and partially approved FMPs and FMP amendments are returned
5 by NMFS to the Council with an explanation of the reasons for disapproval. The Council may then
6 decide whether to revise and resubmit the FMP/amendment. If the Council fails to develop a necessary
7 FMP/amendment, or fails to revise an FMP/amendment following Secretarial disapproval or partial
8 approval within a reasonable period of time, the Secretary may develop a Secretarial FMP/amendment.
9 Secretarial authority to approve, disapprove or partially approve is set out in Section 304(a)(3) of the
10 Magnuson-Stevens Act.

11
12 Amendments to FMPs may be necessitated by a variety of events including new or triggered statutory
13 requirements, operational need, or changes in the fisheries. In addition, the Council annually solicits
14 FMP and regulatory amendment proposals from the public. These proposals are then reviewed, and
15 qualitatively ranked in terms of analytical difficulty and priority for consideration. If a proposal is
16 selected for consideration, then the next step is the preparation of an initial analysis of the proposal.
17 These analyses serve at least three functions. First, they fulfill requirements under certain statutes and
18 executive orders. Second, they provide opportunity for interested or affected members of the public to
19 bring information to the Council's attention regarding the proposed and alternative actions. And third,
20 they help the Council to contrast and compare the potential effects of alternative actions to their stated
21 policy goals and objectives, and make a well-reasoned decision on which amendment proposal to
22 recommend to the Secretary.

23
24 Additional analytical requirements include environmental assessments or environmental impact
25 statements as required by NEPA; a Regulatory Impact Review (RIR) under Executive Order 12866; a
26 Regulatory Flexibility Act (RFA) review; an assessment of potential impacts on marine mammals under
27 the Marine Mammal Protection Act; a review of effects on essential fish habitat under the MSA; a review
28 of effects on the state's coastal zone management program (under the Coastal Zone Management Act); an
29 assessment under the Paperwork Reduction Act; and possibly a federalism impact statement under
30 Executive Order 13132.

31
32 The next step for the Council is to review a draft summary of the initial analysis to determine whether it
33 should be released for public review and comment. In making this decision, the Council relies on the
34 advice it receives from its Advisory Panel and Scientific and Statistical Committee. The Council
35 decision at this point may be to release the initial draft analysis for formal public review as it is, instruct
36 staff to make certain minor revisions to it before releasing it, or request major revisions to it and another
37 Council review before releasing it. Or the Council may decide to suspend further action on the analysis,
38 which would stop further development of the proposal, at least temporarily. If the Council decides to
39 release the initial draft analysis for public review, the comment period normally is scheduled to begin at
40 least four weeks before the next action by the Council on the proposal.

41
42 After a period of public review, the next action by the Council on a management proposal is to decide on
43 its preferred alternative. The Council's choice of a preferred alternative (other than the "no action"
44 alternative) frequently is referred to as the final action of the Council to adopt an FMP or FMP/regulatory
45 amendment for recommendation to the Secretary.

46
47 Once the Council has determined its final recommendation, the recommendation is transmitted to the
48 Secretary of Commerce. The principal documents that are submitted include (a) the proposed FMP text

1 or text changes in the case of an FMP amendment, (b) the draft analysis of potential environmental and
2 socioeconomic impacts of the preferred alternative and other alternatives considered by the Council, and
3 (c) proposed regulations that would implement the action, if it is approved. The document with the
4 proposed implementing regulations is a draft Federal Register notice of proposed rule making.
5

6 After receipt of the official FMP/amendment review package, the Secretary must immediately commence
7 review of the package to determine whether the proposed FMP or FMP amendment is consistent with
8 MSA, including the national standards, and other applicable law and must immediately publish a notice
9 of availability in the Federal Register to start the period of public review. Within 30 days after the public
10 comment period, the Secretary must approve, disapprove or partially approve the FMP amendment by
11 written notice to the Council. If Secretarial action is not taken within the required time period, then the
12 FMP amendment takes effect as if it were fully approved.
13

14 Thus, the MSA vests the Councils with the primary role of developing management measures. The role
15 of the Secretary (normally NMFS, on behalf of the Secretary) is usually limited to approval, disapproval,
16 or partial approval of a Council recommendation. Sec. 304(a)(3) states that if an FMP or FMP
17 amendment is disapproved or partially approved, the written notice to the Council must specify the
18 applicable law with which the FMP/amendment is inconsistent, the nature of the inconsistency, and
19 recommendations for correcting the inconsistency.
20

21 When the Council recommends regulations to implement an FMP or amendment, the Secretary reviews
22 them to determine their consistency with the underlying FMP. If NMFS determines that the proposed
23 regulatory amendment is consistent, then it is published in the Federal Register, but if the determination
24 is negative, again, NMFS must notify the Council in writing specifying the inconsistencies and providing
25 recommendations for revision that would make the proposed regulation consistent. An approved FMP,
26 FMP amendment or regulatory amendment is implemented by publication of a notice of approval or a
27 final rule in the Federal Register. The rule normally is not effective for an additional 30 days after it is
28 published as required under the Administrative Procedures Act.
29

30 **2.4 Annual Fisheries Cycle**

31 The annual fisheries management cycle consists of activities that can be grouped into four main
32 functions: (1) stock assessment, (2) setting the total allowable catch (TAC) levels, (3) implementation of
33 the fisheries, and (4) monitoring the catch and fisheries effects. The activities that comprise these four
34 steps are illustrated in Figure 2.1.
35

36 **2.4.1 Stock assessment**

37 **2.4.1.1 Target species and stocks**

38 In the BSAI region, finfish and invertebrates are grouped into five categories: target, prohibited,
39 other, forage fish, and nonspecified (BSAI FMP Annex VI, p. 402; Table 2.3 here). In 1999 and
40 2000, TACs were determined for the BSAI species or species groups listed in Table 2.4. In the
41 GOA region, finfish and invertebrates are also grouped into five categories: target, prohibited
42 domestic, prohibited foreign, other, and forage fish (GOA FMP Table 3.1, p. 12; Table 2.5 here).
43 In 1999 and 2000, TACs were determined for the GOA species or species groups listed in Table
44 2.6. Species, species groups, and management units targeted under the BSAI and GOA FMPs are
45 as follows.
46
47
48

	Stock	Management units
1		
2		
3	<i>Arrowtooth flounder</i>	Managed as a single unit in the GOA. With Kamchatka flounder, managed as a single unit in the BSAI.
4	<i>Atka mackerel</i>	Managed as separate units in the BSAI and in the GOA.
5	<i>Deep-water flatfish</i>	In the GOA, managed as a complex of three species, including Dover sole, Greenland turbot, and deep-sea sole.
6	<i>Demersal shelf</i>	In the GOA, managed as a complex of seven species, including canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfish.
7	<i>rockfish</i>	
8	<i>Flathead sole</i>	Managed as a single unit in the GOA. With Bering flounder, managed as a single unit in the BSAI.
9	<i>Greenland turbot</i>	Managed as a single unit in the BSAI, and included in the deep-water complex in the GOA.
10	<i>Northern rockfish</i>	Managed as a single unit in the GOA, included in the “other red rockfish” complex in the Bering Sea, and included in the northern/sharpchin complex in the Aleutian Islands.
11	<i>Northern/sharpchin</i>	Managed as a two-species complex in the Aleutian Islands.
12	<i>rockfish</i>	
13	<i>Other flatfish</i>	In the Bering Sea, managed as a complex of sixteen species, including Alaska plaice, Arctic flounder, butter sole, California tonguefish, C-O sole, curlfin sole, deepsea sole, Dover sole, English sole, hybrid sole, longhead dab, Pacific sanddab, petrale sole, rex sole, roughscale sole, sand sole, slender sole, and starry flounder.
14	<i>Other red rockfish</i>	In the Bering Sea, managed as a complex of four species, including northern, rougheye, sharpchin, and shortraker rockfish.
15	<i>Other rockfish</i>	In the Bering Sea and Aleutian Islands, managed as separate complexes of at least 33 species, including aurora, black, blackgill, blue, bocaccio, brown, canary, chameleon, chilipepper, copper, dark blotched, dark dusky, gray, greenstriped, harlequin, pink rose, pygmy, red banded, redstripe, rosethorn, rosy, silvergrey, splitnose, stripetail, tiger, vermilion, widow, yelloweye, yellowmouth, yellowtail, broad banded thornyhead, longspine thornyhead, and shortspine thornyhead rockfishes.
16	<i>Other slope rockfish</i>	In the GOA, managed as a complex consisting of 17 species, including aurora, blackgill, bocaccio, chilipepper, darkblotched, greenstriped, harlequin, pygmy, redbanded, redstripe, sharpchin, shortbelly, silvergrey, splitnose, stripetail, vermilion, and yellowmouth rockfish.

	Stock	Management units
1	<i>Other species</i>	In the BSAI, managed as a complex of at least 44 species, including multiple species of sculpins, sharks, skates and octopus. In the GOA, managed as a complex of at least 30 species, including multiple species of sharks, skates, sculpins, octopus, and squids.
2	<i>Pacific cod</i>	Managed as separate units in the BSAI and GOA.
3	<i>Pacific ocean perch</i>	Managed as five units, including Bering Sea, Aleutian Islands, western GOA, central GOA, and eastern GOA.
4	<i>Pelagic shelf</i>	In the GOA, managed under Amendment 46 to FMP and includes dusky, yellowtail, and widow rockfish.
5	<i>rockfish</i>	
6	<i>Black and blue</i>	In the GOA, managed as multiple area specific units
7	<i>rockfish</i>	
8	<i>Pollock</i>	Managed as five units, including eastern Bering Sea, Aleutian Islands, Aleutian Basin/Bogoslof Island, western/central GOA, and eastern GOA.
9	<i>Rex sole</i>	Managed as a unit in the GOA; included in “other rockfish” in the BSAI.
10	<i>Rock sole</i>	Managed as a single unit in the BSAI; included in the shallow-water complex in the GOA.
11	<i>Sablefish</i>	Managed as separate units in the Bering Sea, Aleutian Islands, and GOA.
12	<i>Shallow-water</i>	In the GOA, managed as a complex consisting of 15 species, including Alaska plaice, butter sole, C-O sole, curlfin sole, English sole, hybrid sole, longhead dab, pacific sanddab, petrale sole, rock sole, roughscale sole, sand sole, slender sole, starry flounder, and yellowfin sole.
13	<i>flatfish</i>	
14	<i>Shortraker/rougheye</i>	In the Aleutian Islands and GOA, managed as separate two-species complexes.
15	<i>rockfish</i>	
16	<i>Squid</i>	Managed as a single unit in the BSAI; consists of multiple species.
17	<i>Thornyhead rockfish</i>	Managed as a single unit in the GOA; included in the “other rockfish” complex in the BSAI; consists of multiple species.
18	<i>Yellowfin sole</i>	Managed as a single unit in the BSAI, and included in the shallow-water complex in the GOA.

19
20 These stocks, their status, and the fisheries on each stock are described in detail in the 2000
21 Stock Assessment and Fishery Evaluation reports for the BSAI and GOA groundfish fisheries.
22 Synopses of those descriptions are included here in Appendix 2.

23
24 **2.4.1.2 Stock surveys**
25

1 Stock assessment consists of two main functions, 1) determining the status (a measure of
2 population size and trend) of the stock and 2) evaluating its tolerance to fishing. Stock surveys,
3 along with the fishery observer program and catch statistics, are essential for assessment of the
4 stocks fished under the BSAI and GOA FMPs. In general, these surveys involve deployment of
5 standardized sampling gear according to consistent protocols to catch or measure fish abundance
6 or biomass at a particular location. Estimates of overall fish abundance or biomass are then
7 based on average catch rates per sampled location multiplied by the size of the total area. The
8 results can be expressed as an index or estimate of abundance or biomass. Results from single
9 surveys may be used separately to generate such indices/estimates, or results from multiple
10 surveys may be combined.

11
12 Three types of surveys are conducted, including bottom trawl for shellfish and bottom fishes,
13 hydroacoustic or echo integration-trawl (EIT) for the dominant semi-pelagic fishes, and longline
14 for bottom fishes (e.g., sablefish) of the deeper waters of the continental shelf and slope.
15 Summer bottom trawl surveys of the eastern Bering Sea have been conducted annually since
16 1972, with the current standardized time series beginning in 1979. These surveys follow a
17 systematic grid of sampling stations. Triennial summer bottom trawl surveys for the Aleutian
18 Islands and the GOA began in 1980 and 1984, respectively. These triennial surveys are based on
19 area and depth-stratified random sampling among a set of predetermined stations. Annual
20 winter EIT surveys were initiated in 1981 to study abundance of spawning pollock in Shelikof
21 Strait, and in 1988 to study pollock abundance in the vicinity of Bogoslof Island. Summer
22 longline surveys were initiated by Japanese scientists in 1979 to assess sablefish abundance over
23 the upper continental slope in the GOA. These surveys are now conducted by U.S. scientists,
24 and have been extended to the Aleutian Islands and the eastern Bering Sea slope, where they are
25 conducted in alternate years. New surveys may be added to the existing survey schedule as
26 follows.

- 27
28 (1) Summer bottom trawl surveys will continue in the eastern Bering Sea.
- 29
30 (2) Summer bottom trawl surveys will be conducted biennially (rather than
31 triennially) in the GOA and Aleutian Islands.
- 32
33 (3) Summer EIT surveys may be initiated on an alternate year basis in the GOA and
34 eastern Bering Sea.
- 35
36 (4) Summer longline surveys will continue for estimation of sablefish abundance.
- 37
38 (5) Winter EIT surveys will continue in the Bogoslof and Shelikof areas on an
39 annual basis.
- 40
41 (6) Winter EIT surveys may be instituted to determine abundance of pollock in sea
42 lion critical habitat.
- 43
44 (7) Based on results of a bottom trawl slope survey this summer (2000), biennial
45 slope surveys may be initiated in the eastern Bering Sea.

46
47 As noted above, surveys are conducted to assess the abundance or biomass of stocks. In addition,
48 they also provide important information on age and sex composition, recruitment of young fish to

1 the fished stock, length and weight at age, reproductive status or condition, food habits, and other
2 pertinent biological characteristics. Assessment of each of these parameters may be affected by
3 sampling variability, measurement error, or systematic bias. Considerable effort is directed at
4 minimizing measurement error and bias, but sampling variability may still occur and must be
5 evaluated and reported to provide an indication of the confidence with which final parameter
6 estimates may be used. Table 2.7 provides an indication of the sampling variability observed for
7 each assessed stock. The error is expressed as the coefficient of variation (CV) which is equal to
8 $((\text{standard error}/\text{estimate}) * 100)$. For example, the CV for pollock in the eastern Bering Sea is
9 23%. This CV indicates that if the surveys were conducted repeatedly under the same
10 conditions, 68% of the time (i.e., ± 1 standard error) the new estimates would fall within the
11 interval from current estimate minus 23% to the current estimate plus 23%. If this estimation
12 procedure is unbiased, then 68% of the time this interval also would be expected to enclose the
13 true value for pollock in the area assessed.

14 **2.4.1.3 Stock modeling**

15
16
17 The second major process in stock assessment is modeling of each stock to further describe its
18 status and investigate its tolerance to fishing. The information required for modeling comes from
19 the stock surveys, from the fisheries themselves, and from other studies. For a given target stock,
20 the objective of modeling is to 1) estimate the state of the population by creating a simulated
21 population that is most consistent with the data on the wild population, and 2) estimate the
22 tolerance of the wild population to fishing based on the characteristics of the simulated
23 population.

24
25 Three types of models or modeling approaches are used for the stocks fished under the BSAI and
26 GOA FMPs (Table 2.7): stock synthesis, AD model builder, and stock index. In general, these
27 models include a range of elements from simple numerical or accounting procedures to complex
28 mathematical functions. The nature and blend of these elements depends, in part, on the
29 information that is available and the preferences of the scientist(s) modeling the stock.
30 Nonetheless, all have the same general purpose of describing the wild stock and evaluating its
31 tolerance to fishing.

32
33 The stock synthesis approach has been the primary modeling tool for the past decade. The
34 approach was developed by Methot (1990) to conduct an age- or length-structured analysis using
35 life history, catch, survey, and other information, as well as the level of uncertainty in such
36 information. Given a set of values for the model parameters (e.g., annual fishing mortality rates
37 and recruitment), a simulated stock is created and subjected to simulated fisheries and surveys
38 for comparison with the real catch and survey data. The degree of similarity between the
39 simulated data and the real data is referred to as the “goodness of fit,” which is expressed in
40 terms of a “likelihood.” The likelihood is then assessed as the probability of the data given the
41 model parameters. The best simulated population (i.e., the one in most agreement with the data)
42 is found by adjusting the model parameters of the simulated population until the likelihood
43 expression is maximized (accomplished using a computer “optimization” routine). The stock
44 assessment authors then complete their assessment by weighing and considering the best
45 simulated population, along with other reasonable or possible model outcomes.

46
47 For evaluation of some stocks, the stock synthesis approach is being replaced or supplemented by
48 analyses using the AD Model Builder (Fournier 1998). AD Model Builder is essentially a set of

1 pre-programmed computer subroutines that enable faster and more reliable estimation of various
2 parameters used in stock assessment modeling and which also enable efficient calculation of the
3 probabilities of alternative parameter values. The equations representing population dynamics
4 and statistical likelihood in models developed under AD Model Builder can take exactly the
5 same form as those in the stock synthesis approach or they can take different forms, thereby
6 enabling exploration of alternative modeling assumptions. In effect, AD Model Builder expands
7 the capabilities of the stock assessment modeling efforts.
8

9 “Stock index modeling” encompasses a variety of assessment approaches that are used to
10 describe the wild population and its tolerance for fishing when the available data are too limited
11 to conduct a full age- or length-based assessment. They are frequently based on indices of the
12 population derived from survey estimates alone.
13

14 Where the data allow, the general modeling approach is to create a simulated population of a
15 particular size (number) and age/sex composition. That is, the model is based on year-classes or
16 cohorts. A new cohort enters the model population in each year of the simulation. The
17 numerical abundance of a cohort at the age where it first enters the model population is a
18 parameter estimated by the model. This is sometimes referred to as “recruitment” to the model
19 population, which may occur at a different age than recruitment to the surveyed population or
20 recruitment to the fished population. For example, for a particular stock the model population
21 might begin at age 1, even though fish in that stock are seldom detected by the survey before age
22 2 or caught in the fishery before age 3. After the age of recruitment to the model, each cohort
23 decays over time due to natural mortality and fishing mortality (when appropriate). As a cohort
24 ages over time in the model, the average length, weight, maturity, and selectivity of fish in the
25 cohort are assumed to vary in predictable fashion. In the wild, these functions may vary
26 unpredictably under a number of influences, including density-independent factors (e.g.,
27 environmental conditions) or density-dependent factors (e.g., stock size). In modeling, however,
28 these functions are generally treated as fixed or constant parameters. The processes of growth,
29 maturation, reproduction, natural mortality, fishing mortality, and recruitment are described in
30 further detail below.
31

32 **Growth**

33
34 Individuals in a cohort grow over time. Information on physical size and growth is
35 important because the replicate and wild populations consist of numbers of individuals,
36 but harvests are measured in terms of biomass. Thus, growth information is necessary to
37 convert numbers available to biomass available. Growth is assessed using samples taken
38 during surveys and from the fisheries catch. The estimated relations may include length
39 as a function of age, weight as a function of age, or weight as a function of length. Age
40 is estimated using the ear bones (otoliths), which exhibit annual growth layers or rings.
41 Weight at age and numbers at age are necessary to determine overall biomass. Weight
42 also appears to be an important determinant of fecundity (number of viable eggs
43 produced by a female).
44

45 **Maturation**

46
47 Maturation is an expression of the reproductive capacity of an individual. While
48 individuals are generally described as “immature” or “mature” (i.e., fully one or the

1 other), maturation may involve physiological and behavioral changes that are not abrupt
2 but transition over a period of time. For example, young females in the process of
3 maturing may be able to produce eggs, but those eggs may not be as viable as the eggs of
4 an older female. Maturation is expressed most often as a function of age but, weight may
5 also be an important determinant of the maturation process. Maturity is assessed using
6 samples taken during surveys and from the fisheries catch. Maturation of all individuals
7 in a cohort may occur over a single year or over a period of several years.
8

9 **Reproduction**

10 As females mature they begin to produce eggs. The number and viability of a female's
11 eggs determine the contribution of that female to the new cohort. However, the size of
12 the cohort at recruitment age is also a function of environmental (e.g., currents,
13 temperature) and ecological (e.g. predators, prey) factors that determine growth and
14 survival from fertilization to recruitment. Depending on the method used for modeling
15 recruitment, reproductive functions may or may not be essential or important for the
16 modeling effort. For example, if recruitment is modeled as a density-independent
17 random variable based on estimates of past recruitment, then reproduction by adult
18 females need not be included explicitly in the model.
19
20

21 **Natural mortality**

22
23 Natural mortality refers to the instantaneous rate of decline of a population or cohort due
24 to natural causes such as disease or predation. The rate of decline may vary as a function
25 of age, but for most fish populations harvested in the BSAI and GOA groundfish
26 fisheries, natural mortality is generally treated as constant for cohorts at or above the age
27 of recruitment to the fishery. In most age- or length-structured stock assessments the
28 natural mortality rate is assumed to be known from previous studies, although
29 occasionally it is estimated within the stock assessment model itself. For fish
30 populations, natural mortality is most often expressed as M in the function
31

$$32 \quad N_1 = N_0 * e^{-(M + F)},$$

33
34 where N_0 and N_1 represent numbers at time 0 and time 1.
35

36 **Fishing mortality**

37
38 F in the above equation, is the instantaneous rate of decline of a population or cohort due
39 to fishing. Age- or length-structured stock assessment models estimate annual fishing
40 mortality rates for each year in a time series as parameters of the model.
41

42 **Recruitment**

43
44 Recruitment is the process by which fish enter some portion of the population, such as
45 the portion available to the fishery. The process may be defined in terms of the age or
46 size of the fish, which are usually closely related. The numbers or biomass of fish
47 recruited to the fishery in a given year is determined by the quantity and quality of
48 reproductive output by mature fish, plus factors that affect the growth and survival of

1 individuals from fertilized egg up to recruitment. Defining the age of recruitment to the
2 model population is largely a matter of convenience and may be governed by such
3 considerations as the youngest age observed in the survey or the youngest age above
4 which natural mortality can reasonably be viewed as constant. Above the age of
5 recruitment to the model population, most stock assessment models treat fishery
6 selectivity as a continuous function of age or size, making designation of “the” age of
7 recruitment to the fishery a somewhat tenuous exercise.
8

9 The modeling of recruitment is a crucial component of population models used for
10 fishery evaluation and projection. The population models used for these fished stocks
11 are “closed” in the sense that they do not include immigration or emigration in or out of
12 the population (except for the possibility that recruitment to the model population could
13 potentially include an immigration component). Therefore, as cohorts are stepped
14 through time (years) they can only diminish in numbers due to natural or fishing
15 mortality. In terms of numbers, the stock or population is replenished only through the
16 addition (recruitment) a new cohort each year.
17

18 Recruitment can be incorporated into fisheries models in a variety of ways, two of which
19 will be described here. First, recruitment can be modeled as a function of the
20 reproductive stock (based on either numbers or biomass) (Fig. 2.2). The shape of an
21 assumed or demonstrated stock-recruitment function is a crucial consideration in
22 modeling recruitment. Importantly, among all the stocks fished under the BSAI and
23 GOA FMPs, a stock-recruitment function has been characterized only for the pollock
24 stock of the eastern Bering Sea.
25

26 The second approach to modeling recruitment is to assume that it is independent of stock
27 size (i.e., density independent). For BSAI and GOA groundfish, the assumption is that
28 while spawning biomass (used as a proxy for number of eggs produced) may be an
29 important determinant of subsequent year class strength when stock size is low,
30 spawning biomass is not an important determinant of subsequent year class strength at
31 stock sizes typically observed. Because stock-recruitment functions have not been
32 identified for the majority of stocks fished under the BSAI and GOA FMPs, recruitment
33 is modeled as a density-independent random variable based on past recruitment levels.
34

35 The significance of these processes in the model depends on the sensitivity of model
36 results to each function and the extent to which the real processes are appropriately and
37 accurately represented in the modeling process. Again, all of the above processes except
38 recruitment are incorporated into the models as fixed rates or schedules, some estimated
39 within the model and others estimated from separate studies. Recruitment is the only
40 model process that is treated stochastically. Uncertainty is incorporated into the model
41 for input data collected in the field (e.g., catch at age, age-length relation, survey
42 biomass).
43

44 **2.4.2 Setting the TAC**

45
46 After the target stocks or stock complexes have been assessed and modeled, the next step in the process
47 is to determine the tolerance of each stock/stock complex to fisheries removal. The TAC for each
48 stock/stock complex is determined annually on the basis of that tolerance plus other considerations (e.g.,

1 social, economic, ecological).
2

3 **2.4.2.1 Surplus production and MSY** 4

5 Stock assessment is generally based on the assumption that the fished populations are closed.
6 Under this assumption, populations can increase in number only through recruitment and can
7 decrease in number only through mortality. That is, the populations are replenished numerically
8 only by the annual addition of a new cohort or year-class. In terms of biomass, the populations
9 change by additions due to recruitment and physical growth, and by losses due to natural and
10 fishing mortality.
11

12 The number of fish constituting the fished part of a population is determined, then, by the
13 combination of ongoing mortality of all cohorts and annual recruitment of a new cohort.
14 Mortality may result from natural causes (i.e., natural mortality), or may result from fishing (i.e.,
15 fishing mortality). Recruitment is determined by a number of factors, the roles of which may
16 vary considerably by (among other things) stock, area, and time. The factors that determine
17 recruitment are a matter of considerable debate and research. For example, the Fisheries-
18 Oceanography Coordinated Investigations (FOCI) program was instigated by the National
19 Oceanic and Atmospheric Administration (NOAA) in 1984 to investigate the factors determining
20 recruitment of pollock in the GOA.
21

22 For an unfished stock of a particular size, recruitment may occur at levels greater than necessary
23 to replace a stock (i.e., maintain the stock at that size). Such “excess” is essential, for example,
24 for population growth. In a deterministic “single-species context”, this excess is considered a
25 surplus that can be removed by fishing without harm to the stock. The concept of surplus
26 recruitment is illustrated by the Ricker (1954) stock-recruitment relation in Figure 2.2. The
27 Ricker curve indicates a density-dependent relation between stock and recruitment where
28 recruitment varies as a function of some measure of stock size (e.g., number or biomass). The
29 Ricker curve also suggests that recruitment reaches a peak at some stock level and then declines
30 with increasing stock size. The excess or surplus recruitment in this case is represented by the
31 vertical difference between the stock-recruitment line and the replacement line. In the simplest
32 case, without random variability and where the fishable stock consists of a single age group, this
33 excess represents sustainable yield. At some stock size, the excess reaches a maximum, which is
34 the maximum sustainable yield. The BSAI FMP (p. 16) defines the maximum sustainable yield
35 as an average over a reasonable length of time of the largest catch which can be taken
36 continuously from a stock under current environmental conditions.
37

38 In the Ricker curve, recruitment reaches a peak and then declines. While the decline could
39 indicate changes in both reproduction of the stock and mortality of pre-recruits, Ricker (1954)
40 attributed it to compensatory mortality of pre-recruits through mechanisms such as predation and,
41 in particular, cannibalism. Thus, the number of young produced probably continues to increase
42 with increasing stock size, but fewer young survive to recruitment. The remainder are “lost” to
43 various forms of mortality.
44

45 **2.4.2.2 MSY proxies and F_x** 46

47 In the absence of evidence for a clear stock-recruitment relation, the question is how to determine
48 what stock size and rate of removal will provide the maximum sustainable yield. Clark (1991)

1 characterized this problem as a question of “how to choose a fixed exploitation rate that will
2 provide a high yield at low risk, when the investigator has no knowledge of the yield curve or th
3 e spawner-recruit relationship of the stock.”
4

5 The GOA FMP (p. 3-4) and the BSAI FMP (p. 16) both state that “where sufficient scientific
6 data as to the biological characteristics of the stock do not exist or the period of exploitation or
7 investigation has not been long enough for adequate understanding of stock dynamics, the MSY
8 will be estimated from the best information available.” Regulations pertaining to optimum yield
9 (50 CFR § 600.310(c)(3)) recognize that alternatives to MSY may be required. The regulations
10 state the following:
11

12 When data are insufficient to estimate MSY directly, Councils should adopt other
13 measures of productive capacity that can serve as reasonable proxies for MSY, to the
14 extent possible. Examples include various reference points defined in terms of relative
15 spawning per recruit. For instance, the fishing mortality rate that reduces the long-term
16 average level of spawning per recruit to 30-40 percent of the long-term average that
17 would be expected in the absence of fishing may be a reasonable proxy for the MSY
18 fishing mortality rate. The long-term average stock size obtained by fishing year after
19 year at this rate under average recruitment may be a reasonable proxy for the MSY stock
20 size, and the long-term average catch so obtained may be a reasonable proxy for MSY.
21 The natural mortality rate may also be a reasonable proxy for the MSY fishing mortality
22 rate. If a reliable estimate of pristine stock size (i.e., the long-term average stock size
23 that would be expected in the absence of fishing) is available, a stock size approximately
24 40 percent of this value may be a reasonable proxy for the MSY stock size, and the
25 product of this stock size and the natural mortality rate may be a reasonable proxy for
26 MSY.
27

28 Clark (1991) suggested that for groundfish with typical life history parameters, “yield will be at
29 least 75% of maximum sustainable yield so long as the spawning biomass is maintained in the
30 range of about 20-60% of the unfished level, regardless of the spawner-recruit relationship.” He
31 also suggested that “relative spawning biomass in this range can be achieved by choosing a
32 fishing mortality rate that will reduce the spawning biomass *per recruit* to about 35% of the
33 unfished level.” (emphasis in original). The fishing mortality rate that will result in a spawning
34 biomass per recruit of about 35% of the unfished level is denoted $F_{35\%}$. Clark’s (1991) results
35 were supported by a review of harvest levels for various fisheries around the world (Mace 1994),
36 and by the analyses of Restrepo et al. (1998).
37

38 In the absence of sufficient information about stock-recruitment relations for the stocks targeted
39 under the BSAI and GOA FMPs, the results of Clark (1991), Mace (1994), and Restrepo et al.
40 (1998) have been used to create surrogate or proxy MSY reference points.
41

42 **2.4.2.3 Limits, targets, and harvest control rules** 43

44 The National Standard Guidelines distinguish between *limiting* reference points (which
45 management seeks to *avoid*) and *target* reference points (which management seeks to *achieve*).
46 In the case of target harvest levels or rates, the Guidelines encourage a precautionary approach as
47 follows (50 CFR § 600.310(f)(5)).
48

- 1 (1) Target reference points should be set safely below limit reference points.
- 2
- 3 (2) A stock that is below its MSY level should be harvested at a lower rate than if
- 4 the stock were above its MSY level.
- 5
- 6 (3) Criteria used to set target catch levels should be explicitly risk averse, so that
- 7 greater uncertainty regarding the status or productive capacity of a stock
- 8 corresponds to greater caution in setting target catch levels.
- 9

10 The Guidelines envision that limit and target fishing mortality rates will often be cast in the form
 11 of “harvest control rules,” which are functions that determine fishing mortality based on stock
 12 size (50 CFR § 600.310(c)(2), § 600.310(f)(4)(ii)). In particular, the Guidelines presume that
 13 MSY will be estimated using an “MSY control rule” which describes how the Council would set
 14 harvest rates if maximization of long-term average yield were its primary goal. An MSY control
 15 rule would be an example of a limit reference point. A wide variety of functional forms can be
 16 used to define harvest control rules (Restrepo et al. 1998).

17
 18 The BSAI and GOA Groundfish FMPs define two sets of harvest control rules which follow the
 19 precautionary approach outlined above to a considerable extent. One set of control rules defines
 20 the limit harvest rate that is used to determine the “overfishing level” (OFL), and the other
 21 defines the upper boundary for the target harvest rate that is used to determine the “acceptable
 22 biological catch” (ABC). The ABC is defined as a preliminary description of the acceptable
 23 harvest (or range of harvests) for a given stock or stock complex. Its derivation focuses on the
 24 status and dynamics of the stock, environmental conditions, other ecological factors, and
 25 prevailing technological characteristics of the fishery.

26
 27 The two sets of harvest control rules in the BSAI and GOA Groundfish FMPs are prescribed
 28 through a set of six tiers which are listed below in descending order of preference, corresponding
 29 to descending order of information availability. For tier (1), a “pdf” refers to a probability
 30 density function. For tiers (1-2), *MSY* refers to maximum sustainable yield, which is the largest
 31 catch which the stock can withstand, on average, over a long period of time (given current
 32 environmental conditions). For tiers (1-3), the coefficient “*a*” is set at a default value of 0.05,
 33 with the understanding that a different value for a specific stock or stock complex may be used if
 34 supported by the best available scientific information. For tiers (2-4), a designation of the form
 35 “*F*” refers to the fishing mortality (*F*) associated with an equilibrium level of spawning biomass
 36 per recruit (SPR) equal to *X*% of the equilibrium level of spawning biomass per recruit in the
 37 absence of any fishing. For tier (3), the term $B_{40\%}$ refers to the long-term average biomass that
 38 would be expected under average recruitment and $F=F_{40\%}$. Tiers for fished stocks are listed in
 39 Table 2.7.

40
 41 Tier 1) Information available: Reliable point estimates of *B* and B_{MSY} and reliable pdf of F_{MSY} .

- 42 1a) Stock status: $B/B_{MSY} > 1$
 43 $F_{OFL} = m_A$, the arithmetic mean of the pdf
 44 $F_{ABC} \leq m_H$, the harmonic mean of the pdf
- 45 1b) Stock status: $a < B/B_{MSY} \leq 1$
 46 $F_{OFL} = m_A \times (B/B_{MSY} - a)/(1 - a)$
 47 $F_{ABC} \leq m_H \times (B/B_{MSY} - a)/(1 - a)$
- 48 1c) Stock status: $B/B_{MSY} \leq a$

- 1 $F_{OFL} = 0$
2 $F_{ABC} = 0$
3 Tier 2) Information available: Reliable point estimates of B , B_{MSY} , F_{MSY} , $F_{35\%}$, and $F_{40\%}$.
4 2a) Stock status: $B/B_{MSY} > 1$
5 $F_{OFL} = F_{MSY}$
6 $F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%})$
7 2b) Stock status: $a < B/B_{MSY} \leq 1$
8 $F_{OFL} = F_{MSY} \times (B/B_{MSY} - a)/(1 - a)$
9 $F_{ABC} \leq F_{MSY} \times (F_{40\%}/F_{35\%}) \times (B/B_{MSY} - a)/(1 - a)$
10 2c) Stock status: $B/B_{MSY} \leq a$
11 $F_{OFL} = 0$
12 $F_{ABC} = 0$
13 Tier 3) Information available: Reliable point estimates of B , $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$.
14 3a) Stock status: $B/B_{40\%} > 1$
15 $F_{OFL} = F_{35\%}$
16 $F_{ABC} \leq F_{40\%}$
17 3b) Stock status: $a < B/B_{40\%} \leq 1$
18 $F_{OFL} = F_{35\%} \times (B/B_{40\%} - a)/(1 - a)$
19 $F_{ABC} \leq F_{40\%} \times (B/B_{40\%} - a)/(1 - a)$
20 3c) Stock status: $B/B_{40\%} \leq a$
21 $F_{OFL} = 0$
22 $F_{ABC} = 0$
23 Tier 4) Information available: Reliable point estimates of B , $F_{35\%}$, and $F_{40\%}$.
24 $F_{OFL} = F_{35\%}$
25 $F_{ABC} \leq F_{40\%}$
26 Tier 5) Information available: Reliable point estimates of B and natural mortality rate
27 M .
28 $F_{OFL} = M$
29 $F_{ABC} \leq 0.75 \times M$
30 Tier 6) Information available: Reliable catch history from 1978 through 1995.
31 OFL = the average catch from 1978 through 1995, unless an alternative
32 value is established by the SSC on the basis of the best available
33 scientific information
34 $ABC \leq 0.75 \times OFL$

2.4.2.4 Status determination

37
38 The MSA requires the Secretary of Commerce to “report annually to the Congress and the
39 Councils on the status of fisheries within each Council’s geographical area of authority and
40 identify those fisheries that are overfished or are approaching a condition of being overfished”
41 (16 U.S.C. § 304(e)(1)). The Guidelines define two “status determination criteria” to be used in
42 making this identification. The first of these, the “maximum fishing mortality threshold”
43 (MFMT), is used to determine whether a stock is being subjected to a rate of fishing mortality
44 that is too high. The second, the “minimum stock size threshold” (MSST), is used to determine
45 whether the stock has fallen to a level of biomass that is too low. Exceeding the MFMT results
46 in a determination that the stock is being subjected to overfishing. Falling below the MSST
47 results in a determination that the stock is overfished.
48

1 More specifically, the Guidelines require that the MFMT be at least as conservative as the MSY
2 control rule (50 CFR 600.310(d)((2)(i)), and they define the MSST as whichever of the following
3 is greater: one-half the MSY stock size, or the minimum stock size at which rebuilding to the
4 MSY level would be expected to occur within 10 years if the stock were exploited at the MFMT
5 (50 CFR 600.310(d)((2)(ii)).
6

7 When expressed in units of catch, the MFMT is equivalent to OFL in the BSAI and GOA FMPs,
8 and when expressed in units of fishing mortality, the MFMT is equivalent to F_{OFL} . Thus,
9 prevention of overfishing is accomplished simply by insuring that catch does not exceed OFL in
10 any given year.
11

12 For each BSAI and GOA groundfish stock managed under tiers 1-3, the following algorithm is
13 used to determine stock status with respect to MSST (Figure 2.3).
14

- 15 • If the stock is below $\frac{1}{2} B_{MSY}$, it is below MSST.
- 16
- 17 • If the stock is above B_{msy} , it is also above MSST.
- 18
- 19 • If the stock is between $\frac{1}{2} B_{MSY}$ and B_{MSY} , then 1000 simulations are conducted in which
20 the population is projected forward 10 years with randomly varying recruitment and with
21 fishing mortality set equal to F_{OFL} in all years. Recruitment is drawn from a probability
22 distribution based on recruitment estimates from 1978 to 1998.
- 23
- 24 • If the average ending stock size in these simulations is above B_{msy} , the stock is above its
25 MSST.
- 26
- 27 • If the average ending stock size in these simulations is below B_{msy} , the stock is below its
28 MSST.
29

30 MSSTs can not be estimated for certain stocks because the necessary reference stock levels can
31 not be estimated reliably. These stocks are (by definition) managed under harvest tiers 4-6.
32

33 The stock is considered to be *approaching* an overfished condition if NMFS (for the Secretary)
34 estimates that the stock will become overfished within two years (16 U.S.C. 1854 § 304(e)(1)).
35 For each BSAI and GOA groundfish stock managed under tiers 1-3, the determination as to
36 whether the stock is approaching an overfished condition is made on the basis of 1000
37 simulations in which the population is projected forward 12 years with randomly varying
38 recruitment and with fishing mortality set equal to the maximum permissible value of F_{ABC} for the
39 first two years and equal to F_{OFL} thereafter:
40

- 41 • If the mean spawning biomass for the third year is below $\frac{1}{2} B_{MSY}$, the stock is
42 approaching an overfished condition.
- 43
- 44 • If spawning biomass for the third year is above B_{MSY} , the stock is not approaching an
45 overfished condition.
- 46
- 47 • If spawning biomass for the third year is between $\frac{1}{2} B_{MSY}$ and B_{MSY} , the determination
48 depends on the mean spawning biomass at the end of 12 years.

- If the average ending stock size in these simulations is below B_{MSY} , the stock is approaching an overfished condition.
- If the average ending stock size in these simulations is above B_{MSY} , the stock is not approaching an overfished condition.

2.4.2.5 From ABC to TAC

ABC and OFL are first recommended by the stock assessment authors, who evaluate the biological state of the fished stock and its tolerance for fishing. Their recommendations are summarized in Stock Assessment and Fishery Evaluation (SAFE) reports. SAFE reports provide the Council with “a summary of information concerning the most recent biological condition of stocks and the marine ecosystems in the FMU [fishery management unit] and the social and economic condition of the recreational and commercial fishing interests, fishing communities, and the fish processing industries. [They summarize], on a periodic basis, the best available scientific information concerning the past, present, and possible future condition of the stocks, marine ecosystems, and fisheries being managed under Federal regulation” (50 CFR § 600.315(e)(1)). Each SAFE report must be scientifically based and should contain (50 CFR § 600.315(e)(2-3)).

- (1) information on which to base harvest specifications,
- (2) a description of the maximum fishing mortality threshold and the minimum stock size threshold for each stock or stock complex, along with information by which the Council may determine (a) whether overfishing is occurring or any stock is overfished, and whether overfishing or overfished conditions are being approached, and (b) any measures necessary to rebuild an overfished stock.

Each report may also contain “additional economic, social, community, essential fish habitat, and ecological information pertinent to the success of management or the achievement of objectives of each FMP” (50 CFR § 600.315(e)(4)).

The BSAI FMP (p. 287) and GOA FMP (p. 20) require the following minimum contents of the SAFE reports.

- (1) Current status of Bering Sea and Aleutian Islands area groundfish resources, by major species or species group.
- (2) Estimates of MSY and ABC.
- (3) Estimates of groundfish species mortality from nongroundfish fisheries, subsistence fisheries, and recreational fisheries, and differences between groundfish mortality and catch, if possible.
- (4) Fishery statistics (landings and value) for the current year.
- (5) The projected responses of stocks and fisheries to alternative levels of fishing

1 mortality.

- 2
- 3 (6) Any relevant information relating to changes in groundfish markets.
- 4
- 5 (7) Information to be used by the Council in establishing prohibited species catch
- 6 limits (PSCs) for prohibited species and fully utilized species with supporting
- 7 justification and rationale.
- 8
- 9 (8) Any other biological, social, or economic information which may be useful to
- 10 the Council.
- 11

12 The stock assessments and recommendations are reviewed by the BSAI and GOA groundfish

13 plan teams, which consist of members from the Alaska Fisheries Science Center, ADFG, the

14 Washington Department of Fisheries, the U.S. Fish and Wildlife Service, the International

15 Pacific Halibut Commission, and the University of Alaska at Fairbanks. The plan teams then

16 prepare their recommendations to the Council's Advisory Panel and Scientific and Statistical

17 Committee, and the main body of the Council. The Council's Scientific and Statistical

18 Committee has final authority for determining whether a given item of information is "reliable"

19 for the purpose of determining ABCs and OFLs, and may use either objective or subjective

20 criteria in making such determinations.

21

22 TAC

23

24 Based on the reviews and recommendations of the stock assessment authors, the plan

25 teams, the Scientific and Statistical Committee, and the Advisory Panel, the Council then

26 considers the ABC and OFL levels for each stock, and pertinent social, economic, and

27 ecological information to determine a total allowable catch (TAC) for each stock or

28 stock complex under the BSAI and GOA FMPs.

29

30 The TAC for a specific stock or stock complex may be sub-divided for biological and

31 socio-economic reasons according to percentage formulas established in FMP

32 amendments. For particular target fisheries, TAC specifications are further allocated

33 within management areas (eastern, central, western Aleutian Islands; Bering Sea; eastern,

34 central, western GOA; Figs. 2.4 and 2.5), among management programs (open access or

35 community development quota program), processing components (inshore or offshore),

36 specific gear types (trawl, non-trawl, hook-and-line, pot, jig), and seasons according to

37 regulations.

38

39 The Council and its committees review the information and recommendations and

40 consider TAC specifications at both their October and December meetings. Once a final

41 recommendation has been made, NMFS proposes the Council's recommended TAC

42 levels as a proposed rule. After a public comment period, NMFS publishes a final rule,

43 usually around February or March of the fishing year. However, the TAC specifications

44 define upper harvest limits for the year from January 1 to December 31. Therefore, a set

45 of interim TAC specifications is required to start the fishery. Regulations provide that

46 interim TACs are either the first seasonal allowance or equal to one-fourth of the

47 previous year's TAC specifications and apportionments thereof toward fisheries

48 occurring in the first quarter of the calendar year. The TAC specifications for 1999 and

1 2000 are listed in Tables 2.4 and 2.6. TAC specifications for 2001 are under
2 development will be changed by the RPAs in Chapter 9 of this document if necessary.

3 4 **Optimum yield**

5
6 The BSAI FMP (p. 285) states:

7
8 “The groundfish complex and its fishery are a distinct management unit of the
9 Bering Sea. The complex has more than 10 commercially important species and
10 many others of lesser or no commercial importance. This complex forms a large
11 subsystem of the Bering Sea ecosystem with intricate interrelationships between
12 predators and prey, between competitors, and between those species and their
13 environment. Therefore, the productivity and MSY of groundfish should be
14 conceived for the groundfish complex as a unit rather than for many individual
15 species groups.”

16
17 Under the MSA, optimum yield is prescribed on the basis of the maximum sustainable
18 yield from each fishery, as reduced by any relevant economic, social, or ecological factor
19 (16 U.S.C. 1802 § 3(28)(B)). In both the BSAI FMP (p. 285-286) and GOA FMP (p. 16),
20 the concept of optimum yield has been applied to the sum total of the groundfish catch in
21 these regions. In 1981, optimum yield for total BSAI groundfish catch was set as a range
22 from 1.4 million mt to 2.0 million mt. The endpoints of the range were determined by
23 subtracting 15% from the endpoints of the range of MSY estimates available at that time.
24 The BSAI FMP (p. 285) justified the 15% reduction by stating that it 1) reduces the risk
25 associated with relying upon incomplete data and questionable assumptions in
26 assessment models used to determine the condition of stocks, and 2) is probably a
27 conservatively safe level for the groundfish complex.

28
29 In 1986, optimum yield for the total GOA groundfish catch was set as a range from
30 116,000 mt to 800,000 mt (GOA FMP, p. 16). The low end of the range is
31 approximately equal to the lowest historical groundfish catch during the 21-year period
32 from 1965 to 1985. The upper end is approximately equal to the lowest MSY estimate
33 from the period 1982 to 1986.

34 35 **2.4.2.6 Incidental catch**

36
37 While fishery participants may target a certain species, they are not 100% effective in limiting
38 their catch to that specific target. Other fishes and marine life are also caught to varying degrees
39 depending on target species, gear type and fishing method, area fished and habitat type, season,
40 depth, and other physical and biological factors. These other fishes and marine life are referred
41 to as “incidental catch” or “bycatch.”⁵ Whether a species or stock is caught as a target by a
42 fishing vessel, or incidentally by a vessel after another target, the catch is supposed to be

⁵ The terms “incidental catch” and “bycatch” are often used to mean catch of species or marine life not targeted. In regulations, the terms are given specific meanings. “Incidental catch” applies to the unintended catch of species that may be targeted or the unintended catch of species other than prohibited species. “Bycatch” is used in the regulations to refer to the incidental catch of prohibited species.

1 included against the overall total allowed for a species or stock. That is, TACs are intended to
2 represent the sum of all catch including targeted catch and incidental catch.

3 4 **2.4.2.7 Bycatch of prohibited species**

5
6 Prohibited species include Alaska king crab, Tanner and snow crab, Pacific halibut, Pacific
7 salmon species and steelhead trout, and Pacific herring. With some exceptions (explained
8 below) retention is prohibited in the BSAI and GOA groundfish fisheries to eliminate any
9 incentive to target these species.

10 11 **Crab**

12
13 Alaska king, Tanner and snow crab fisheries are managed by the State of Alaska, with
14 federal oversight and following guidelines established in the FMP for the BSAI crab
15 fisheries (NPFMC 1989). The commercially important crab species are: red king crab,
16 blue king crab, golden or brown king crab, Tanner crab, and snow crab. Crabs use
17 benthic habitat, which is vulnerable to destruction and alteration by bottom trawling. In
18 the BSAI, the Bristol Bay Habitat Conservation Area, the Red King Crab Savings Area,
19 and the Pribilof Islands Habitat Conservation Area serve to protect crab habitat. In the
20 GOA, seasonal and year-round closures are used to protect crab habitat in the EEZ and
21 Alaska state waters.

22
23 Bycatch of king, Tanner, and snow crab in groundfish fisheries is a significant issue.
24 Typically, the crab bycatch are juveniles. PSC limits for each species by zone and by
25 fishery closes the fishery for the remainder of the season when the PSC limit has been
26 reached. Area closures and a vessel incentive program are also used to limit crab
27 bycatch (Witherell and Pautzke 1997). Trawl fisheries are limited to less than 1% of crab
28 populations, except for Tanner crab in Zone 2. However, trawling may also cause
29 unobserved mortality and habitat degradation, and closed areas are likely to be more
30 effective than PSC limits in reducing the impacts of trawling on crab stocks (Witherell
31 and Harrington 1996).

32 33 **Pacific halibut**

34
35 Pacific halibut fisheries are managed by a treaty between the United States and Canada
36 through recommendations of the International Pacific Halibut Commission (IPHC).
37 Pacific halibut is considered as one large interrelated biological stock; but it is regulated
38 by subareas through catch quotas, time-area closures, and since 1995 in Alaska, by an
39 IFQ program adopted by the Council and implemented by NMFS.

40
41 Bycatch of Pacific halibut constrains the groundfish fisheries in both the BSAI and
42 GOA, preventing the TAC of many groundfish target species from being harvested. In
43 recent years, halibut mortality limits of 3,675 mt for trawl and 900 mt for non-trawl
44 fisheries have been established in the BSAI. Halibut mortality limits for the GOA can be
45 changed each year as part of the annual specification process, but in recent years they
46 have remained at 2,000 mt for trawl and 300 mt for non-trawl fisheries. For each gear
47 type, these caps have been further apportioned by target species and for each individual
48 target species, further apportioned by season. This halibut bycatch management program

1 has the effect of directing fisheries to the highest volume or highest value target species
2 with the lowest seasonal halibut bycatch rates throughout the fishing year. Total bycatch
3 is estimated by extrapolating observed vessel catch to unobserved vessels. In recent years
4 pot gear, jig gear, and hook-and-line gear targeting sablefish under the IFQ program have
5 been exempted from halibut mortality limitations. Other measures taken to reduce the
6 bycatch mortality of halibut have included area closures (both seasonal and year round),
7 careful release requirements, a vessel incentive program to hold individual vessels
8 accountable for excessive bycatch, public reporting of individual vessel bycatch rates,
9 and gear modifications.

10 **Pacific salmon**

11
12
13 Pacific salmon and steelhead fisheries off the coast of Alaska are managed under a
14 complex mixture of domestic and international bodies, treaties, regulations, and other
15 agreements. Federal and state agencies cooperate in managing salmon fisheries. The
16 ADFG manages salmon fisheries within state jurisdictional waters where the majority of
17 harvest occurs. Management in the EEZ is primarily the responsibility of the Council.
18 Regulation of the directed salmon fishery occurring in the EEZ off southeast Alaska is
19 deferred to the state. The EEZ off central and western Alaska is closed to directed
20 salmon fisheries. Management of Alaska salmon fisheries is based primarily on regional
21 stock groups of each species and on time and area harvesting by specific types of fishing
22 gear. Over 25 different commercial salmon fisheries in Alaska are managed with a
23 special limited-entry permit system that specifies when and what type of fishing gear can
24 be used in each area. Gear types include drift gillnets, set gillnets, beach seines, purse
25 seines, hand troll, power troll or fish wheel harvest gear. Sport fishing is limited to
26 hook-and-line, while subsistence fishers may use gillnets, dip nets, or hook-and-line.
27 Some subsistence harvesting of salmon is also regulated by special permits. Harvesting
28 of Pacific salmon on the high seas is prohibited

29
30 Five species of Pacific salmon, pink, chum, sockeye, coho, and chinook salmon as well
31 as steelhead trout occur in Alaska. All five species of salmon are fully utilized. Alaska
32 commercial salmon harvests generally increased over the last three decades but may have
33 peaked in 1995 (Burger and Wertheimer 1995, Wertheimer 1997). A number of factors
34 have contributed to the current high abundance of Alaska salmon, including 1) pristine
35 habitats with minimal impacts from extensive development; 2) favorable ocean
36 conditions that allow high survival of juveniles; 3) improved management of the fisheries
37 by state and federal agencies; 4) elimination of high-seas drift-net fisheries by foreign
38 nations; 5) hatchery production; and 6) reduction of bycatch in fisheries for other
39 species. Nonetheless, the potential for overfishing, bycatch in other fisheries, and loss of
40 freshwater and nearshore marine habitat are still important issues that are addressed in
41 the FMPs.

42
43 All groundfish fisheries are prohibited from retaining salmon, but the salmon must be
44 held for counting and collection of scientific samples by an observer before discarding
45 (and salmon can be turned over to food banks for distribution). Most salmon bycatch is
46 taken by vessels using pelagic trawl gear targeting pollock. Between January 1 and April
47 15 in the Bering Sea, the PSC limit for trawl gear is 48,000 chinook salmon in the
48 Chinook Salmon Savings Area. Between August 15 and October 15, the PSC limit is

1 42,000 non-chinook salmon in the Catcher Vessel Operational Area (CVOA). In the
2 GOA, PSC limits have not been established for salmon, although the timing of seasonal
3 openings for pollock in the central and western GOA have been adjusted to avoid periods
4 of high chinook and chum salmon bycatch.
5

6 **Pacific herring**

7
8 Pacific herring fisheries occur in specific areas of the GOA and the Bering Sea when the
9 stocks come inshore to spawn. In the GOA, spawning concentrations occur mainly off
10 southeastern Alaska, in Prince William Sound, and around the Kodiak Island-Cook Inlet
11 area. In the Bering Sea, the centers of abundance are in northern Bristol Bay and Norton
12 Sound. The fisheries occur within state waters and are, therefore, managed by the State
13 of Alaska. Although most herring are harvested in the sac-roe season in spring, fall
14 seasons are also designated for food and bait harvesting. The ADFG regulates and
15 monitors the resource and associated fisheries.
16

17 Pacific herring bycatch is limited for trawl groundfish fisheries in the Bering Sea. The
18 limit is determined each year during the TAC-setting process, and is set at 1 percent of
19 the estimated eastern Bering Sea herring biomass. The limit is then apportioned by
20 target fishery. Should the PSC limit for a particular groundfish target be reached during
21 the fishing year, the trawl fishery for that species is closed in the Herring Savings Areas.
22

23 **PSC management measures**

24
25 A variety of management measures have been used to control the bycatch of prohibited
26 species, including 1) PSC limits by fishery for selected prohibited species (red king crab,
27 Tanner and snow crab, Pacific halibut, Pacific salmon, and Pacific herring in the BSAI
28 and Pacific halibut in the GOA); 2) time and area closures; 3) seasonal apportionments
29 of groundfish TACs; 4) gear restrictions; 5) groundfish TAC allocations by gear type; 6)
30 reductions in groundfish TACs; 7) at-sea and on-shore observer programs to monitor
31 bycatch; 8) a vessel incentive program with civil penalties for fishing vessels that exceed
32 established bycatch rates for Pacific halibut or red king crab; 9) required retention of
33 Pacific salmon bycatch until counted by an observer; 10) Individual Transferable Quota
34 (ITQ) management for the fixed-gear Pacific halibut and sablefish fisheries; 11) careful
35 release regulations for longline fisheries; and 12) public reporting of individual vessel
36 bycatch rates.
37

38 Groundfish fisheries or fisheries under the FMPs for which the quota has been reached
39 shall be treated in the same manner as prohibited species. Species identified as
40 prohibited must be avoided while fishing groundfish and must be immediately returned
41 to the sea with a minimum of injury when caught and brought aboard, except when their
42 retention is authorized by other applicable law.
43

44 **2.4.3 Fisheries Removal**

45 **2.4.3.1 Fishery status**

46
47 The fishery for a target species may be categorized as open to directed fishing, closed to directed
48

1 fishing, or prohibited. When a species fishery is open to directed fishing, vessels are allowed to
2 target and retain it with no restrictions on the amount harvested. If the catch is expected to reach
3 the TAC and some amount of TAC must be held in reserve for incidental catch in other fisheries,
4 then a portion of the TAC may be established as a “directed fishing allowance,” meaning that
5 directed fishing is allowed only on that portion of the TAC. For example, for the BSAI pollock
6 fishery, 5% of the TAC is established as an “incidental catch allowance” and the directed fishery
7 is based on the remaining 95% of the TAC. For fisheries other than BSAI pollock, the amount
8 for a “directed fishing allowance” is determined by NMFS as the season progresses, and is
9 established by an in-season regulatory action. Once the directed fishing allowance for a species
10 is taken, the fishery is closed to directed fishing. When a species is closed to directed fishing,
11 vessels are allowed to retain up to the maximum retainable amounts shown in Tables 2.8 and 2.9
12 at any time during the fishing trip. This provision does allow targeting for the species on a haul-
13 by-haul basis, as long as the maximum retainable amount for the trip is not exceeded. If the
14 catch reaches the TAC, then the status changes to “prohibited,” and retention is prohibited for the
15 rest of the year. If NMFS determines that harvest of a species will reach the OFL, then the
16 Regional Administrator has the authority to close the fisheries in which the species is taken to
17 prevent overfishing.

18 19 **2.4.3.2 Access and permits**

20
21 Until recently, access to fishing was generally open within the following constraints and with the
22 following exceptions. Nearly all vessels and plants harvesting or processing groundfish from
23 federal waters in the BSAI and the GOA are required to comply with federal permit
24 requirements. In 2000, the permit requirements are as follows.

25
26 ***Catcher vessels:*** Federal Fisheries Permit, License Limitation Program Permit, American
27 Fisheries Act (AFA) Permit;

28
29 ***Catcher/processors and motherships:*** Federal Fisheries Permit, Federal Processor Permit,
30 License Limitation Program Permit, AFA Permit;

31
32 ***Shore plants:*** Federal Processor Permit, AFA Permit;

33
34 ***IFQ vessels:*** IFQ Permit, IFQ Card;

35
36 ***IFQ buyers and processors:*** Registered Buyer Permit.

37
38 In 2000, the License Limitation Program (LLP) replaced the vessel moratorium program and
39 qualifying vessels were issued LLP permits instead of moratorium permits. The LLP permits are
40 based on the vessel catch history during the LLP qualifying period (the general qualification
41 period was January 1, 1988 to June 27, 1992).

42
43 The following vessel categories are exempt from the license program requirements.

- 44
45 1. Vessels fishing in State of Alaska waters (0-3 miles offshore).
 - 46
47 2. Vessels less than 32' LOA in the BSAI and 26' in the GOA.
- 48

- 1 3. Jig gear vessels less than 60' LOA using a maximum of 5 jig machines, one line
2 per machine, and a maximum of 15 hooks per line.
- 3
- 4 4. GOA vessels using fixed gear to fish sablefish and demersal shelf rockfish in the
5 southeast outside area (east of 140°). Vessels exempted from the GOA
6 groundfish license program are limited to the use of legal fixed gear in the
7 southeast outside area.
- 8
- 9 5. BSAI vessels using fixed gear for to fish sablefish.

10
11 Hook-and-line sablefish fisheries are managed under Individual Fishing Quota (IFQ) programs.
12 AFA permits are issued for those vessels and plants qualified to harvest or process pollock in the
13 BSAI. The AFA also allowed for fishing cooperatives for the three sectors (other than the
14 Community Development Quota [CDQ] sector) fishing BSAI pollock. Experimental Fisheries
15 Permits authorize fishing for groundfish in a manner that would otherwise be prohibited and that
16 otherwise may not be available through research or commercial fishing operations. Under
17 specific conditions, Letters of Authorization are issued to qualified research agencies to fish
18 groundfish outside the established TAC quotas. Scientific research may be conducted by either
19 fishery research vessels or fishing vessels chartered by NMFS.

20 21 **2.4.3.3 Sector and gear allocations**

22
23 Gear types authorized by the FMPs are trawls, hook-and-line, pots, jigs, and other gear as defined
24 in regulations. Gear types and sector allocations for specific BSAI fisheries are listed in Table
25 2.10. In the BSAI, pollock is allocated among four sectors, with 10% of the TAC allocated to the
26 CDQ Program, 5% held in reserve for incidental catch, and the remainder split among the
27 inshore, mothership, and catcher/processor sectors in the ratio of 50:10:40, respectively. For all
28 other BSAI fisheries (except sablefish - see below), 7.5% of the TAC is held as reserve for CDQ.
29 After removal of CDQ reserve for Pacific cod, the remainder is allocated to jig (2%), hook-and-
30 line (51%) and trawl (47%), with the trawl portion split evenly between catcher vessels and
31 catcher/processors. For sablefish in the Bering Sea, hook-and-line and pot together are allocated
32 50% and trawl is allocated 50%. For sablefish in the Aleutian Islands, hook-and-line and pot
33 receive 75% and trawl 25%. (Twenty percent of hook-and-line/pot allocation is held as CDQ
34 reserve, as is 7.5% of the trawl allocation.) For Atka mackerel, 2% of the allocation goes to jig
35 gear. 15% of each target species or species group, except for fixed gear sablefish, is placed in a
36 non-specified reserve category.

37
38 In the GOA (Table 2.11), 20% of pollock, cod, flatfish and “other” species is held for initial
39 reserve, and 100% of the pollock allocation goes to the inshore sector. For Pacific cod, the
40 allocation is split 90% to the inshore sector and 10% to the offshore sector. Sector allocations
41 are not made for flatfish, rockfish, or other species in the GOA. The purpose of the reserves is to
42 give management the flexibility needed to prevent the catch from exceeding the TAC.

43 44 **2.4.3.4 Spatial and temporal division of TACs and catch**

45
46 The temporal and spatial distribution of TAC and catch varies for each of the groundfish
47 fisheries managed under the BSAI and GOA FMPs. Areas used in fisheries management are
48 illustrated in Figs. 2.4 and 2.5, and also listed in the TAC specifications tables (Tables 2.4 and

1 2.6). In the BSAI, no spatial allocations are made for Pacific cod, yellowfin sole, Greenland
2 turbot, arrowtooth, rock sole, flathead sole, other flatfish, squid, and other species. Atka
3 mackerel is allocated spatially among eastern, central, and western regions of the Aleutian
4 Islands, and inside and outside of Steller sea lion critical habitat. True Pacific ocean perch is
5 allocated among the eastern Bering Sea and eastern, central, and western regions of the Aleutian
6 Islands. Other POP is allocated only for the eastern Bering Sea. Sablefish, and other rockfish
7 are allocated between the eastern Bering Sea and the Aleutian Islands. Pollock is allocated to the
8 eastern Bering Sea, Bogoslof area, and Aleutian Islands regions, but Bogoslof and Aleutian
9 Islands region allocations are for incidental catch only. In the eastern Bering Sea, pollock is also
10 allocated inside and outside of the Steller Sea Lion Conservation Area (SCA), which is
11 comprised of the southeastern Bering Sea special foraging area of Steller sea lion critical habitat
12 and the portion of the catcher vessel operation area to the east of the special foraging area.
13

14 In the GOA, spatial allocations of TAC are generally made to the western, central, west Yakutat,
15 and east Yakutat/southeast outside regions. Exceptions include 1) pollock, where the Central
16 region is split into area 620 and 630 and a Shelikof Strait management area is used in the A and
17 B seasons; 2) Pacific cod, shortraker/rougheye, and thornyhead whose allocations are just to
18 western, central, and eastern regions; 3), Atka mackerel, and other species whose allocations are
19 gulf-wide (i.e., no allocation on a spatial basis); and 4) demersal shelf rockfish whose TAC is
20 specified in the Eastern Regulatory Area by the Council, and ADFG manages the fishery in this
21 portion of their range .
22

23 In establishing fishing seasons, the BSAI FMP and GOA FMP require the Council to consider
24 the following criteria.
25

26 *Biological:* spawning grounds, migration, biological factors
27

28 *Bycatch:* biological and allocative effects of season changes.
29

30 *Exvessel and wholesale prices:* effects of season changes on prices.
31

32 *Product quality:* producing the highest quality product to the consumer.
33

34 *Safety:* potential adverse effects on people, vessels, fishing time, and equipment.
35

36 *Cost:* effects on operating costs incurred by the industry as a result of season changes.
37

38 *Other fisheries:* possible demands on the same harvesting, processing, and transportation
39 systems needed in the groundfish fishery.
40

41 *Coordinated season timing:* the need to spread out fishing effort over the year, minimize
42 gear conflicts, and allow participation by all elements of the groundfish fleet.
43

44 *Enforcement and management costs:* potential benefits of seasons changes relative to
45 agency sources available to enforce and manage new seasons.
46

47 *Allocation:* potential allocation effects among users and indirect effects on coastal
48 communities.

Temporal allocations for the BSAI fisheries are listed in Table 2.10. For the majority of the BSAI fisheries, trawling is open from January 20 to December 31, and fishing with non-trawl gear is open from January 1 to December 31. Greenland turbot is limited to the period from May 1 to December 31. Trawling for Atka mackerel is allocated equally between two seasons from January 20 to April 15 and from September 1 to November 1. Non-trawl fishing for Atka mackerel is open year-round. The Pacific cod TAC is released in three allowances: January 1 to April 30 (71% annual TAC), May 1 to August 31 (0% annual TAC), and September 1 to December 31 (29% annual TAC) --- Pacific cod is effectively fished in two seasons. Pollock TAC is allocated among four seasons inside the SCA: January 20 to April 1 (30% annual TAC), April 1 to June 10 (10% annual TAC), June 10 to August 20 (30% annual TAC), and August 20 to November 1 (30% annual TAC). Outside the SCA, the first two inside seasons are combined to form one season, and the third and fourth inside seasons are combined into a second outside season, as illustrated below.

Outside SCA	A+B (40% annual TAC)		C+D (60% annual TAC)	
Inside SCA	max 15% annual TAC	max 5% annual TAC	max 4.5% annual TAC	max 7.5% annual TAC
Season	A	B	C	D
	Jan. 20	Apr. 1	Jun. 10	Aug. 20
				Nov. 1

Temporal allocations for the GOA fisheries are listed in Table 2.11. For the majority of the GOA fisheries, trawling is open from January 20 to December 31, and fishing with non-trawl gear is open from January 1 to December 31. Trawling for rockfish is open from July 1 to December 31. Pollock TAC is allocated among four seasons: January 20 to March 1 (30% annual TAC), March 15 to May 31 (15% annual TAC), August 20 to September 15 (30% annual TAC) and October 1 to November 1 (25% annual TAC).

2.4.3.5 Time/area closures

In addition to temporal and spatial allocation of TACs, certain areas are closed seasonally, year-round, or under special circumstances as established in regulations. In the BSAI region, these time/area closures are as follows (BSAI FMP p. 302).

- Prohibited species bycatch limitation zones and areas (Fig. 2.6) include the following.
 - A. Red King Crab Zone 1 (see description under next bullet).
 - B. Red King Crab Zone 2 (see description under next bullet).
 - C. Crab and Halibut Protection Zone. Trawling is not permitted in this zone.
 - D. Herring Savings Areas. For the time periods listed, all trawling is prohibited in an herring savings area when the herring PSC limit (set at 1% of biomass) is attained.
 - 1) Summer Herring Savings Area 1 (June 15 to July 1).
 - 2) Summer Herring Savings Area 2 (July 1 to August 15).
 - 3) Winter Herring Savings Area (September 1 to March 1).

1 E. *C. Opilio* Bycatch Limitation Zone. Upon attainment of the bycatch allowance
2 of *C. opilio* specified for a particular fishery category, the zone is closed to
3 directed fishing for that category for the remainder of the year or the remainder
4 of the season.

- 5
6 • Prohibited species catch (PSC) limits include the following.

7
8 A. Red King Crab - A Zone 1 PSC limit for red king crab is established in the
9 following manner.

10
11 When the number of mature female red king crab is below or equal to the
12 threshold of 8.4 million mature crab or the effective spawning biomass is less
13 than 14.5 million lb., the Zone 1 PSC limit will be 35,000 red king crab.

14
15 When the number of mature female red king crab is above the threshold of 8.4
16 million mature crab and the effective spawning biomass is equal to or greater
17 than 14.5 but less than 55 million lb., the Zone 1 PSC limit will be 100,000 red
18 king crab.

19
20 When the number of mature female red king crab is above the threshold of 8.4
21 million mature crab, and the effective spawning biomass is equal to or greater
22 than 55 million lb., the Zone 1 PSC limit will be 200,000 red king crab.

23
24 B. The PSC limit(s) for *C. bairdi* Tanner crab is established by regulation based on
25 abundance of *C. bairdi* crab as indicated by the NMFS bottom trawl survey.

26
27 C. The PSC limit(s) for *C. opilio* crab is established by regulation based on total
28 abundance of *C. opilio* as estimated by the NMFS bottom trawl survey.
29 Minimum and maximum PSC limits also are established by regulation.

30
31 D. Annual BSAI-wide Pacific halibut bycatch mortality limits for trawl and non-
32 trawl gear fisheries will be established in regulations and may be amended by
33 regulatory amendment. When initiating a regulatory amendment to change a
34 halibut bycatch mortality limit, the Secretary, after consultation with the
35 Council, will consider information that includes:

- 36
37 1. Estimated change in halibut biomass and stock condition;
38 2. Potential impacts on halibut stocks and fisheries;
39 3. Potential impacts on groundfish fisheries;
40 4. Estimated bycatch mortality during prior years;
41 5. Expected halibut bycatch mortality;
42 6. Methods available to reduce halibut bycatch mortality;
43 7. The cost of reducing halibut bycatch mortality;
44 8. Other biological and socioeconomic factors that affect the
45 appropriateness of a specific bycatch mortality limit in terms of FMP
46 objectives.

- 47
48 • Trawl fishing area restrictions are imposed at the following areas:

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- A. Pribilof Islands Habitat Conservation Area: closed to all trawling from January 1 to December 31.
 - B. Chum Salmon Savings Area: closed to trawling from August 1 to August 31. If 42,000 non-chinook salmon have been caught by trawl from August 15 through October 14 in the CVOA, NMFS will prohibit fishing with trawl gear for the remainder of the period September 1 through October 14 in the chum salmon savings area.
 - C. Chinook Salmon Savings Area: closed to trawling from January 1 to April 15 if 48,000 chinook salmon are caught by trawl from January 1 to April 15.
 - D. Red King Crab Savings Area: closed to non-pelagic trawling year round, except that a portion may be opened at the discretion of the Alaska Director.
 - E. Nearshore Bristol Bay Trawl Closure: closed to all trawling on a year round basis, with the exception of a subarea that remains open to trawling April 1 to June 15 each year.

- Amendment 13 to the BSAI FMP prohibited groundfish fishing in waters seaward of 3 miles out to 12 miles around the Walrus Islands (Round Island and the Twins) and Cape Peirce from April 1 through September 30.

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In the GOA (GOA FMP, p. 28-30), a time/area closure has been developed to protect and rebuild the King Crab stock around Kodiak. Three area types have been designated as follows. In Type I areas, bottom trawling is closed year round. In Type II areas, bottom trawling is prohibited during the soft-shell season (February 15 to June 15). Type III areas are those that may be converted to Type I or Type II if a recruitment event occurs. A Type III area is open to bottom trawling until the number of females assessed for the area meets or exceeds the number required to hold a crab fishery. If a crab fishery is initiated, then no closure is in effect. If no crab fishery is initiated, then the Regional Administrator may designate the Type III area as a Type I or II area based on the information available. Type I, II, and III areas are illustrated on page 29 of the GOA FMP, and coordinates of the areas are listed on page 30.

38
39
40
41
42

In both the BSAI and GOA, a series of time/area closures were established in the early 1990s and again in 1998 and 1999 to prohibit trawling and pollock trawling around Steller sea lion rookeries and major haulouts. Specific sites are listed in Table 2.12. In addition, principal sea lion rookeries in the BSAI and GOA are protected by 3-nm “no entrance” zones.

43
44
45

Beginning in 1999, the Aleutian Islands (areas 541, 542, and 543; Figure 2.4) were closed to directed fishing for pollock.

46 47

2.4.3.6 Age/size structure of stocks and catch

48

Age/size structure of fished stocks is estimated on the basis of survey information and the

1 age/size distribution of the catch. The age/size distribution of the catch is determined from
2 observer sampling of catch on vessels and in processing plants. Larger fish are generally sought,
3 as they provide greater market value and flexibility (e.g., large pollock can be filleted as well as
4 ground into surimi). Market/economic constraints are considered sufficient to keep the fisheries
5 targeting older/larger catch.
6

7 **2.4.3.7 Reproductive condition of catch**

8

9 Two kinds of restrictions pertain to the reproductive condition of the catch. Second, the fishing
10 of stocks during their reproductive period may be indirectly affected by seasonal and spatial
11 allocation of TAC. For example, the catch of pollock in the BSAI and GOA during the winter
12 and spring seasons is limited to 40% and 45% of the annual TACs, respectively, thereby limiting
13 the amount of reproductive pollock that can be taken in those periods. Other than these
14 constraints, stocks may be fished during their reproductive period.
15

16 **2.4.3.8 Forage fishes, other species and non-reported species**

17

18 Forage fishes are listed in Tables 2.3 and 2.5. Directed fishing for forage fish is prohibited in the
19 BSAI and GOA groundfish fisheries. They are taken as incidental catch in amounts up to several
20 hundred tons per year.
21

22 Other species consist primarily of sculpins, sharks, skates, squid, and octopus. Many species of
23 sculpins are taken as incidental catch. From 1992 to 1995, total annual catch ranged from 6,000
24 to 11,000 mt in the BSAI and from 500 to 1,400 mt in the GOA. Based on annual BSAI surveys,
25 this catch ranges from 1% to 4% of the estimated biomass of sculpins.
26

27 From 1992 to 1995, annual incidental catch of sharks ranged from 300 to 700 mt in the BSAI and
28 500 to 1,400 mt in the GOA. Shark biomass in the BSAI and GOA is unknown.
29

30 From 1992 to 1995, annual incidental catch of skates ranged from 13,000 to 17,000 mt in the
31 BSAI and 1,000 to 2,000 mt in the GOA. Based on annual BSAI surveys, this catch ranges from
32 1% to 4% of the estimated biomass of skates.
33

34 Non-reported species include a range of vertebrate (fish) and invertebrate species that are not of
35 commercial value and for which no data is collected. Their occurrence in the BSAI and GOA
36 groundfish fisheries, or the effects of the fisheries on these species is, therefore, unknown.
37

38 **2.4.4 Monitoring and Evaluation of Fisheries Catch**

39

40 Catch data used to manage the groundfish fisheries under the BSAI and GOA FMPs are collected from
41 vessels, processors, and fishery observers trained by NMFS. This section discusses recordkeeping and
42 reporting requirements, data used for catch estimation, and the inseason fishery management programs.
43

44 **2.4.4.1 Recordkeeping and reporting requirements**

45

46 Fishery participants issued federal fisheries permits, federal processor permits, groundfish LLP
47 permits and AFA permits are required to comply with record keeping and reporting requirements
48 to report groundfish harvest, discard, receipt, and production (50 CFR § 679.5). Reporting

1 requirements include both logbooks maintained at the shoreside processing plant or onboard the
2 processor vessel, and forms that are submitted to NMFS. Information common to all the
3 logbooks includes: participant identification; amount and species of harvest, discard, and
4 product; gear type used to harvest the groundfish; area where fish were harvested; and observer
5 information.

6
7 Catcher vessels and buying stations (tender vessels and land-based buying stations) are required
8 to record fishery information in logbooks daily. Processors (motherships, catcher/processors,
9 shoreside processors, and stationary floating processors) are required to record fishery
10 information in logbooks daily, summarize the information on Weekly Production Reports and
11 submit them by fax or using an approved electronic reporting system to NMFS. To assist NMFS
12 in determining fishing effort by species, processors also report the start and end of their
13 participation in fishing operations (Check-in/Check-out Reports). CDQ groups must submit
14 CDQ Catch Reports to NMFS detailing the groundfish and prohibited species catch by vessels
15 fishing for the CDQ group.

16 17 **2.4.4.2 Collection of catch data**

18
19 Catch accounting for groundfish and prohibited species is based on logbook data, data collected
20 by observers, and detailed location data collected the automated Vessel Monitoring System.

21 22 **Estimating catch weight**

23
24 Observers provide estimates of total catch and species composition, and species-specific
25 biological data used in stock assessments. Observers are required aboard vessels 125
26 feet or greater in length overall (LOA) for 100% of their fishing days, and aboard vessels
27 60-124 feet LOA for 30% of their fishing days. Observers are required at shoreside and
28 floating processing plants according to processing rate, with 100% observer coverage of
29 plants processing 1,000 metric tons or more per month, and 30% observer coverage of
30 plants processing 500 to 1,000 metric tons per month. Observers have multiple duties,
31 but highest priority is given to estimation of catch weight, species composition, and
32 timely inseason reporting. Haul-specific total catch weights are estimated by observers
33 using volumetric, direct weight, or tally methods. Volumetric and direct weight methods
34 of catch weight estimation are applied primarily in trawl fisheries, while tally methods
35 are used in hook-and-line and pot fisheries. Observers are instructed to make
36 independent estimates of catch weight for as many hauls/sets as possible. Unverified
37 vessel estimates of catch weight are reported by observers as Official Total Catch (OTC)
38 for hauls and sets where observers are unable to make an independent estimate. In 1997,
39 observers independently estimated 72% of hauls/sets aboard observed vessels,
40 accounting for 68% of the total reported observed OTC of 1.5 million metric tons.
41 Vessel estimates were used for 7% of hauls/sets (10% of OTC by weight), and alternate
42 estimates (proportioned delivery weight, expansion from sampled to unsampled hook-
43 and-line sets, etc.) were used for the remaining 20% of hauls/sets (22% of OTC by
44 weight). The catch estimation methods used by observers vary among the vessel types,
45 due to differences in available equipment and in fishery operations.

46
47 Observers aboard catcher vessels make volumetric (usually cod-end) estimates of catch
48 weight for individual hauls at sea. In some cases this is not possible due to large codend

1 sizes. Discard information is also collected. When the vessel delivers to a shoreside
2 processor, the catch is weighed on scales. The observer then uses the at-sea volumetric
3 estimates and any discard information to proportion the delivery weight back to
4 individual haul weights. If an observer is unable to make volumetric estimates at sea,
5 vessel estimates of individual haul weights may be used to proportion the delivery
6 weight.
7

8 In-line flow scales are installed aboard many catcher/processor vessels and can provide
9 accurate individual haul weights. The trawl catcher/processors which fish under AFA or
10 CDQ regulations are required to weigh their catches using NMFS-inspected, in-line
11 motion-compensated scale systems. All fish coming aboard these vessels are weighed,
12 and the weights are reported to NMFS by the observer. The observer also has a role in
13 monitoring the daily testing of the scale to ensure it is accurate.
14

15 Catch weight is estimated by tally methods aboard hook-and-line and pot vessels.
16 Observers count or estimate the total number of hooks in each set, tally the number and
17 species caught in sampled sections of the set, estimate the average weight of individuals
18 of each species sampled, and multiply these average species weights and numbers by the
19 number of hooks in the entire set.
20

21 When observers do not make an independent estimate of total catch or obtain a weighed
22 catch from a flow scale, a vessel estimate of total catch is used as OTC. Variable
23 methods are applied on different vessels for obtaining vessel estimates of catch weight.
24 The accuracy or precision of vessel estimates, or the effect of their incorporation into
25 observer reported Official Total Catch, are unknown.
26

27 **Estimating species composition**

28

29 On all vessel types, hauls to be sampled for species composition are selected at random.
30 Samples must be collected from different parts of the haul and samples must total at least
31 300 kg. Sampling methods are determined by conditions on the vessel and may be
32 biased. On hook-and-line and pot vessels, observers use tally methods to sample for
33 species composition.
34

35 **Estimating discards**

36

37 In most cases, estimation of at-sea discards is based on the observer's best guess at the
38 percentage of each species that is retained. This estimate may be more standardized
39 between observers on catcher vessels where portions of hauls are discarded or all
40 discards occur within the observer's view at one point on deck. In some cases the
41 discarded catch is retained by the vessel long enough for the observer to make a
42 volumetric estimate of weight, or to weigh each species, if the amount discarded is very
43 small; these circumstances are rare. The estimate of at-sea discard aboard
44 catcher/processors may be less standardized between observers, because discards occur
45 simultaneously at multiple points from the deck and throughout the factory, often after
46 the observer has taken the samples.
47

48 **2.4.4.3 Reporting of catch data**

1 **Vessel data**
2

3 Observers record catch weight and effort information from vessel logbooks and their
4 own estimates of catch and effort. The data is sent to the Observer Program by various
5 methods, depending on the level of technology available on the vessel. The Observer
6 Program has implemented a comprehensive electronic reporting system (called ATLAS)
7 on processing vessels and at shoreside processors. The program allows the observer to
8 send raw data which is automatically error checked and incorporated into NMFS
9 databases. It also allows daily communication between observers in the field and
10 Observer Program staff. Currently, the program is installed on most catcher/processors
11 and shoreside processors. Further expansion of the system to catcher vessels that deliver
12 to shoreside processors is planned.
13

14 Weekly summary reports of observer data are sent to the Alaska Region for use in
15 groundfish and prohibited species accounting. Daily reports are sent as needed to
16 monitor specific fisheries.
17

18 **Processor data**
19

20 All processors that receive groundfish from any vessel holding a federal fisheries permit
21 are subject to federal reporting requirements and must report all groundfish and
22 prohibited species from all vessels and areas. Processors must maintain a Daily
23 Cumulative Production Logbook (DCPL). NMFS issues logbooks for Shoreside
24 Processors, Mothership Processors, and Catcher/Processors. Daily production amounts
25 by species and product type, and vessel reports of discards are recorded in Mothership
26 and Catcher/Processor Logbooks. Daily landing weights of fish by species, as well as
27 daily products derived from those landings, are recorded in Shoreside Processors
28 Logbooks. Weekly cumulative totals are reported to NMFS. The weekly reports contain
29 amounts of each species and product type, including discards, aggregated by federal
30 reporting area, gear type, and whether the catch accrues to the CDQ fishery or a standard
31 groundfish quota. Completed logbooks are forwarded to NMFS Enforcement, which
32 maintains them in hard copy. Shoreside processors may use a NMFS-approved
33 electronic logbook. Processors that receive groundfish harvested by AFA catcher vessels
34 are required to use a NMFS-approved electronic reporting system. The electronic
35 reporting system provides information to the species level on each delivery of fish, and
36 provides more detail on catch by vessel and harvest location. These data are submitted
37 to NMFS daily, rather than weekly.
38

39 **Vessel monitoring system data**
40

41 A vessel monitoring system (VMS) consists of a Global Positioning System (GPS) unit
42 and satellite communication device configured as a tamper-proof system. The VMS
43 determines vessel location in latitude and longitude at the resolution available from the
44 GPS system and transmits the vessel identifier, position, and time to NMFS. VMS data
45 are used to monitor compliance with closed areas and to verify the location of catch
46 when separate quotas are established inside small or irregularly shaped areas that do not
47 correspond with the standard reporting or statistical areas.
48

1 **2.4.4.4 Estimation of groundfish catch**
2

3 Groundfish catch is estimated using information from weekly production reports and observer
4 reports. These data are used differently depending on the industry component. For shoreside
5 processors, landed weights from the weekly reports are used to account for the landed component
6 of catch, and these weights are used in conjunction with observer data from catcher vessels
7 which deliver to shoreside processors to estimate at-sea discards of groundfish. For observed
8 catcher/processors and motherships, catch is estimated by comparing observer and weekly
9 production records and picking one or the other based on their consistency. For unobserved
10 processor vessels, the weekly production report provides the only source of data on groundfish
11 catch by species. Observer data from observed vessels are used to estimate prohibited species
12 catch for the unobserved vessels.
13

14 Catch is also estimated from processor records. Again, the results are summed by species, gear,
15 and area across all processors to obtain the total catch for the fishery. Total groundfish catch
16 from the groundfish catch accounting system is also used as the basis for computing estimates of
17 prohibited species catch. The different reports and quota monitoring processes for groundfish
18 catch accounting vary by processing sector. Observers at shoreside plants collect biological
19 samples, but do not verify the accuracy of landed weights.
20

21 NMFS estimates at-sea discards by extrapolating observed discard rates from catcher vessels
22 delivering to shoreside processors to the total catch. Observers on catcher vessels delivering to
23 shoreside processors collect data on at-sea discards of groundfish. All observer data for a month,
24 gear, and target fishery are used to calculate discard rates for each groundfish species they
25 observe being discarded. These discard rates are expressed as a ratio of the weight of the
26 discarded species to the total retained groundfish weight. These discard rates are multiplied by
27 the retained landings for each shoreside processor to make an estimate of total at-sea discards of
28 groundfish.
29

30 **2.4.4.5 Comparing catch to TAC**
31

32 The sub-allocation of TACs among areas, sectors, and seasons results in a set of quotas
33 monitored by NMFS. The CDQ program receives a percentage of the TAC for each groundfish
34 species or species group fished in the BSAI, and a percentage of allowed limits for PSC. The
35 overall CDQ suballocation is further divided into six quotas for each of the six CDQ participants.
36 These quotas are monitored based on reports submitted from each CDQ group to NMFS, and
37 corroborated by observer data, shoreside processor reports, or reports of IFQ landings. The
38 sablefish IFQ fishery is monitored based on records from a real-time transaction processing
39 system. The AFA pollock fishery TAC is divided among a catcher/processor sector, a
40 mothership sector, and an inshore sector with seven inshore cooperatives and an open-access
41 allocation for inshore vessels not participating in a cooperative. All pollock caught by vessels
42 using pelagic trawl gear is attributed to directed fishing, and pollock caught with bottom trawl
43 gear is considered incidental catch. The pollock cooperatives actively monitor their harvest and
44 cease fishing activity when their catch equals their quota. NMFS also monitors the pollock
45 harvest and can close a cooperative fishery if needed.
46

47 Separate pollock quotas have been established for the SCA in the Bering Sea. NMFS monitors
48 pollock catch to ensure that the pollock quota inside the SCA is not exceeded. For observed

1 catcher vessels, the haul retrieval location as recorded by the observer is used to establish the
2 location of catch. Vessels with observers can fish both inside and outside the SCA during a
3 single trip, with the observer reports of haul location providing information on the amount caught
4 inside the SCA. Vessels without observers may carry a VMS unit that provides detailed
5 information on vessel location and speed. These vessels may fish either entirely inside or
6 entirely outside the SCA during a single trip, and the VMS data are used to verify the reported
7 fishing location. If they fish both inside and outside the SCA during a single trip, the pollock
8 catch for the entire trip is counted against the SCA pollock quota, as NMFS has no way to verify
9 the proportion of catch caught outside the SCA on an unobserved vessel. Catches from
10 unobserved vessels that do not provide VMS data are counted against the SCA pollock quota
11 regardless of the vessel's claimed fishing location, as NMFS has no way to verify the catch
12 location on an unobserved vessel without VMS. If the SCA is closed to fishing for pollock
13 because the SCA quota is reached, the requirement to provide VMS data to have unobserved
14 pollock catch counted outside the SCA is removed.
15

16 For the general groundfish fishery, which is all groundfish fishing that is not under the CDQ,
17 IFQ, and AFA Cooperative Programs, NMFS monitors catch and issues regulatory notices to
18 open and close specific fisheries. In some cases catch is monitored from daily or weekly reports
19 and the closure date is projected by extrapolating catch rates. In cases where fishing effort is
20 high relative to the available quota, NMFS will estimate the length of the fishery using historic
21 effort and catch rates, and open the fishery for a specific length of time, ranging from as little as
22 six hours up to several days.
23

24 A running total of PSC is maintained from a combination of observer reports from vessels and
25 processors, extrapolated when necessary to unobserved vessels and processors. Where sufficient
26 observer data is not available, other means of estimated PSC may be required, such as use of
27 historical data on catch rates for specific sectors, gear types, or areas.
28

29 **2.4.4.6 Retention/utilization**

30
31 All vessels participating in the BSAI and GOA groundfish fisheries are required to retain all
32 catch of all designated IR/IU (improved retention/improved utilization) species (pollock and cod
33 beginning January 1, 1998 and shallow water flatfish beginning January 1, 2003) when directed
34 fisheries for those species are open, regardless of gear type employed and target fishery. When
35 directed fishing for an IR/IU species is prohibited, retention of that species is required only up to
36 any maximum retainable incidental catch amount in effect for that species, and these retention
37 requirements are superseded if retention of an IR/IU species is prohibited by other regulations.
38 No discarding of whole fish of these species is allowed, either prior to or subsequent to that
39 species being brought on board the vessel. At-sea discarding of any processed product from any
40 IR/IU species is also prohibited, unless required by other regulations. All IR/IU species caught
41 in the GOA must be either (1) processed at sea subject to minimum product recovery rates and/or
42 other requirements established by regulations, or (2) delivered in their entirety to onshore
43 processing plants for which similar processing requirements are implemented by state
44 regulations.
45

46 **2.4.4.7 Evaluation of fishery effects**

47
48 The fundamental purpose of this consultation and resulting opinion is to assess the effects of the

1 fisheries on listed species and their critical habitat. Effects may occur directly on listed species
2 or critical habitat, or indirectly through changes in the ecosystem, including target species, non-
3 target species, habitat, and the ecosystem at large. In this section, we describe the methods used
4 to assess the effects of the fisheries on target species, non-target species, habitat, and the affected
5 ecosystems.
6

7 **Target species**

8
9 The effects of fishing on target species are monitored through the same process used to
10 establish TAC levels; i.e., stock surveys and stock modeling to determine tolerance to
11 fishing. These surveys occur annually to triennially and provide trend and status
12 information on fished stocks. Assessment information is also available from the fisheries
13 themselves (as described above in sections 2.4.4.1 - 2.4.4.4).
14

15 **Non-target species**

16
17 In the BSAI and GOA, catch of prohibited, other, and forage fish is monitored by
18 observers on vessels and at processors, and by vessel and processor logs. The effects of
19 the groundfish fisheries on prohibited, other, and forage fish are based on comparison of
20 estimated catch with estimated biomass of the stock or stock complex if such information
21 is available. Where stock biomass or stock status is unknown, the effects are assumed to
22 be insignificant if the estimated catch is relatively small. For example, the biomasses of
23 octopus and sharks are not assessed in either region, the catches are on the order of
24 hundreds of metric tons, and are therefore assumed to be insignificant. Similarly, the
25 catch of forage fish is considered insignificant with respect to the reproductive capacity
26 of these species. Total catch of forage fish is estimated to have been about 1000 mt for
27 1994 and 1995. In 1999, catch for the forage fish category was estimated at 63 mt in the
28 BSAI and 218 mt in the GOA. The significance of catch of non-specified species is
29 unknown, as these species are not reported.
30

31 **Habitat**

32
33 Both the BSAI FMP (p. 269) and the GOA FMP (p. 282) state the following with regard
34 to monitoring of fishery effects on habitat:
35

36 The NPFMC (Council) and the Secretary of Commerce have taken appropriate
37 actions when threats to fish habitat have been identified. These include
38 cumulative effects from fishing activities and non-fishing activities. Cumulative
39 effects have been examined in the Stock Assessment and Fishery Evaluation
40 (SAFE) reports, which are produced annually for the crab, scallop, and
41 groundfish fisheries. In addition, an Ecosystem Considerations section to the
42 SAFE reports is prepared which identifies specific ecosystem concerns that are
43 considered by fishery managers in maintaining sustainable marine ecosystems.
44

45 The BSAI FMP (p. 272) and the GOA FMP (p. 285) also state the following with regard
46 to habitat conservation and enhancement recommendations for fishing threats to EFH:
47

48 Area closures to trawling and dredging in the BSAI area serve to protect EFH

1 from potential adverse impacts caused by these gear types. Other management
2 measures, such as the Pribilof Islands Habitat Conservation Area, the Bristol Bay
3 Closure Area [BSAI] and the proposed Cape Edgecumbe Pinnacle closure
4 [GOA], are designed to reduce the impact of fishing on marine ecosystems.
5 Catch quotas, bycatch limits and gear restrictions control removals of prey
6 species. Studies that compare seafloor habitats in areas heavily trawled with
7 areas that have had little trawl effort and research efforts on Alaskan scallops
8 may reveal future habitat conservation and enhancement measures necessary to
9 protect EFH. Additionally, the annual review of existing and new EFH
10 information during the SAFE development process is expected to identify
11 adverse effects to EFH from fishing and proposals to amend the FMP to
12 minimize those adverse effects. Proposals can be submitted during the Council's
13 plan amendment cycle.
14

15 Recent habitat research reported in the 2000 SAFE document (ecosystems
16 considerations) include underwater video to identify and characterize Atka mackerel
17 reproductive habitat, submersible-based line transect surveys of trawled versus untrawled
18 seafloor habitat near Kodiak Island in the GOA, video investigation of nearshore habitat
19 use by juvenile groundfish in southeast Alaska, studies of the effects of urbanization on
20 essential fish habitat in estuarine wetlands, trawl impact studies in the eastern Bering
21 Sea, evaluation of acoustic technology for seabed classification, development of a
22 benthic sled to observe seafloor habitat, retrospective analysis of benthic community
23 structure in areas of high and low commercial bottom trawl effort in the GOA and
24 Aleutian Islands, observations of one-year-old trawl tracks from a research submersible,
25 effects of trawling on hard bottom habitat in the Aleutian region at Seguam Pass, and
26 description and distribution of coral in the GOA and the Bering Sea.
27

28 **Effects on ecosystem composition and processes**

29

30 Ecosystem research is focused on the effects of fishing on exploited resources and non-
31 exploited resources, the habitat requirements of species, climate- and fishing-induced
32 changes to habitat (physical water properties, biological water properties such as prey,
33 and cover/substrate). Research categories include fisheries oceanography, predator-prey
34 interactions, human impacts, and habitat identification. A review of marine ecosystem
35 research in Alaska was undertaken in 1997 to advise the NMFS Ecosystem Principles
36 Advisory Panel on the scope of ecosystem related research that was ongoing in each of
37 the fishery management regions. Marine ecosystem research programs in the Alaska
38 region include the following. While these programs are part of the FMPs, they provide
39 information relevant to the assessment of the effects of the groundfish fisheries.
40

41 NMFS Pinniped Ecosystem Studies in Alaska focus primarily on Steller sea lion,
42 northern fur seal and harbor seals. The purpose of these studies is to define foraging
43 behavior, evaluate responses to changing prey base, develop techniques to measure
44 availability of prey and evaluate their role in marine ecosystems.
45

46 NOAA's Coastal Ocean program has sponsored for several years the Southeast Bering
47 Sea Carrying Capacity Program. The goal of this program is to increase understanding of
48 the southeastern Bering Sea ecosystem, document the role of juvenile pollock in the

1 ecosystem, and examine factors that influence pollock survival and develop indices of
2 pre-recruit pollock abundance..
3

4 NMFS Resource Ecology and Ecosystem Modeling Program looks at groundfish feeding
5 ecology and trophic interactions with other species in the NE Pacific and Bering Sea.
6 This program has a field and lab component to quantify groundfish trophic interactions
7 and incorporates those data into single species, multispecies, and ecosystem models.
8 This program is attempting to develop indicators of ecosystem change to provide early
9 warning of climate- or human-induced effects. Quantifying food web linkages is
10 essential to increase our understanding of how external forces such as fishing may cause
11 unanticipated shifts in ecosystem composition. The group also takes the lead in
12 providing an Ecosystem Considerations document to accompany the standard stock
13 assessment advice provided to Councils/Regions. This document compiles status and
14 trends of ecosystem components and provides ecosystem management indicators to
15 assess efficacy of ecosystem-based management measures. Research focus has been on
16 understanding how fishing 1) influences predator-prey relationships through selective
17 fishing practices that selectively removes a particular predator or prey, 2) re-directs
18 energy in the food web through discarding practices, 3) causes unintended or
19 unmeasured mortality to non-target species, or 4) affects system or community level
20 measures such as diversity.
21

22 NMFS Stock Assessment and Multispecies Modeling Program provides annual stock
23 assessments for groundfish to assist Councils/Regions in evaluating potential biological
24 consequences of proposed fishery management schemes. This group is working to
25 incorporate climate and predation research into stock assessments, evaluating
26 spatial/temporal implications of fishery catch relative to marine mammal foraging areas,
27 performing a pilot survey to assess impacts of commercial harvest on local abundance
28 and distribution of key sea lion prey species, developing initial descriptions of essential
29 fish habitat for managed groundfish.
30

31 NOAA's OAR Arctic Research Initiative, administered through the University of
32 Alaska-Fairbanks looks at natural variability of and anthropogenic influences on the
33 Bering Sea/Western Arctic ecosystems. A variety of research projects have been funded
34 in the past, including those investigating the Bering Sea "green belt" (an area of high
35 production near the shelf edge), arctic haze, ozone, and UV flux, and contaminant
36 sources, transports and dispersion and effects on humans and ecosystems.
37

38 The US GLOBEC Northeast Pacific Program is charged with understanding the effects
39 of climate variability and climate change on the distribution, abundance, and production
40 of marine animals, particularly juvenile salmon and the dominant zooplankton relied on
41 as prey. This research helps explain the role of climate in fish production changes,
42 information that is valuable in differentiating between climate and human effects.
43

44 Ecosystem research on Alaska seabirds is ongoing through the USFWS Bering Sea/AI
45 Ecosystem Action Plan. This plan outlines a monitoring approach of measuring bird
46 abundance, reproductive success and food habits. The EVOS-funded APEX program
47 had multiple projects relating seabird population trends in the Gulf of Alaska to forage
48 fish and oceanography. The NVP (nearshore vertebrate predator) program of EVOS

1 related marine mammal and bird population trends in Prince William Sound to oil
2 pollution and availability of forage fish. USGS-BRD has looked at flight ranges and
3 foraging, food versus reproductive success and trophic levels of marine birds.
4

5 NMFS Auke Bay Lab Habitat Section uses a combination of lab/field studies to examine
6 effects of resource development on selected species and their habitats using an
7 ecosystem perspective. This program has investigated food web tracers, effects of mine
8 tailings on living marine resources, and importance of salmon buffer strips. The Auke
9 Bay Ocean Carrying Capacity Program is working to understand the role of North Pacific
10 ocean conditions in determining productivity of fish with emphasis on salmonid carrying
11 capacity. It has been looking at salmonid energetics linked to behavior and habitat
12 conditions and evaluating effects of temperature and predator/prey densities on growth
13 and consumption.
14

15 OAR/NMFS joint Fisheries Oceanography Coordinated Investigations group works on
16 understanding the influence of the environment on the abundance of various
17 commercially important fish and shellfish stocks in Alaska waters and their role in the
18 ecosystem. The group's focus has been on the early life stages of walleye pollock and
19 their associated ecology.
20

21 ADFG and Game has performed several studies examining predator-prey relationships
22 and climate factors on Alaska marine resource production. Recruitment patterns of crab
23 and salmon have been examined with respect to physical oceanography. Pacific cod and
24 shrimp predator prey interactions have also been studied.
25

26 Environmental assessments conducted under the National Environmental Policy Act also
27 assess the effects of the fisheries on the environment.
28

29 **Effects on listed species and critical habitat**

30

31 Monitoring of the distribution, abundance, and status of the endangered whale species in
32 the BSAI and GOA is based on observer reports from fishing vessels and the presence of
33 scientific staff on the vessels that conduct groundfish surveys. The majority of
34 information on these species is from past records of commercial whaling. Survey efforts
35 in 1999 were sufficient to estimate abundance of fin and humpback whales, but not
36 sufficient to estimate abundance of sei, northern right, blue, or sperm whales. Bowhead
37 whales were considered to be north of the surveyed area at the time of the survey.
38

39 Most of the research related to fishery effects on listed species is related to the Steller
40 sea lion. Such research includes population monitoring; long-term marking for
41 estimation of vital rates; assessment of body morphometrics for population and
42 individual health; assessment of physiological parameters for fitness and health; genetics
43 for identification of population structure, movements, effects on the gene pool, and
44 fitness; diet for predator/prey interactions and importance of prey types over time and
45 space; foraging ecology including distribution and behavior; modeling for evaluation of
46 population status and trends; and captive studies for physiology, growth, behavior, diet,
47 and health.
48

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The section 7 consultation process is an important management tool for assessing the effects of fisheries on listed species and critical habitat. NMFS conducts internal consultations for actions related to the species considered in this opinion, and consults with the USFWS for actions that may affect listed species or critical habitat under their jurisdiction.

3 ACTION AREA

The action area means “all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action” (50 CFR 402.02(d)). As such the action area for the Federally managed BSAI groundfish fisheries effectively covers all of the Bering Sea under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands west of 170°W long. to the border of the U.S. EEZ (BSAI FMP, p. 20; Fig. 2.4). The GOA FMP (p. 7) applies to “the U.S. Exclusive Economic Zone of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance at 132°40' W longitude (Fig. 2.5).” These regions encompass those areas directly affected by fishing, and those that are likely affected indirectly by the removal of fish at nearby sites. The action area would also, necessarily, include state waters as they are areas that will be affected indirectly by the federal action of authorizing the EEZ fisheries pursuant to the FMP..

The action area, as described, includes the Alaska range of both the western (endangered) and eastern (threatened) populations of the Steller sea lion. However, the effects of the Federal FMPs on the Steller sea lions, generally occur within the range of the western population of that species. Therefore, for purposes of this consultation, the action area is further defined as those areas (as described in the above paragraph), but which occur west of 144° W long. (the defined boundary of the western population of Steller sea lions).

A review of areas fished by the groundfish fisheries (Fritz et al. 1998) suggests that virtually the entire Bering Sea and the GOA (from the continental slope shoreward) is utilized by one fishery or another; therefore, the action area for this consultation includes the entire Bering Sea. Of those fisheries identified in the FMPs, and which occur in the defined action area, several have been identified as likely to compete with Steller sea lions for available forage. These include the Atka mackerel fishery, the pollock fishery and the Pacific cod fishery. Additionally, state managed fisheries for salmon and herring have been identified in previous biological opinions (and discussed in Section 7.0 of this biological opinion) as fisheries that also likely interact with Steller sea lions.

The component of the action area that encompasses the Atka mackerel fishery extends from the eastern border of management area 541, which runs through the Islands of the Four Mountains, to the western border of area 543, just west of Stalemate Bank, or midway between Attu Island (U.S.) and Medney Island (Russia). The north and south borders of these management areas are 55°N lat. and the boundary of the EEZ south of the Aleutian Islands, respectively. Twenty Steller sea lion rookeries and 28 major haulouts are located in this region. Virtually all of the fishery occurs within these limits. Seventy percent or more of the fishery in 1995 through 1997 occurred within Steller sea lion critical habitat (i.e., within 20 nautical miles of these rookeries and haulouts or within the Seguam Pass foraging area designated as critical habitat).

However, the potential impacts of the fishery may extend beyond management areas 541, 542, and 543. First, sea lions may forage over relatively wide ranges (Merrick and Loughlin 1997), and sea lions from rookeries or haulouts adjacent to the management areas may, therefore, be affected if prey is reduced within their foraging range. Second, the Atka mackerel stock also may range beyond the areas fished. Lowe and Fritz (1997) suggest that Atka mackerel in the more western regions may constitute, at least to

1 some degree, a source population for Atka mackerel found further east. If that is the case, then fishing
2 may affect stock abundance in areas outside the three management areas.
3

4 The component of the action area that encompasses the pollock fishery includes both the BSAI and the
5 western and central GOA. The action area for the BSAI pollock fishery can be estimated using a) the
6 observed distribution of the fishery (Fritz 1993, Fritz *et al.* 1998) from the 1970s to the present; b) the
7 estimated distribution of pollock stocks in the Bering Sea; and, c) the distribution of Steller sea lions that
8 forage in areas where pollock stocks are fished or where pollock biomass is affected by fishing in other
9 locations. The observed distribution of the fishery effectively encompasses the entire Bering Sea from
10 about 62°N lat. to the shelf break south of the Aleutian Islands, from the eastern areas of Bristol Bay to
11 the Aleutian Basin and Donut Hole, and along the Aleutian Islands at least as far west as the Semichi
12 Islands. Areas of concentrated effort include the Eastern Bering Sea (EBS) shelf, along the shelf break
13 from the Aleutian Islands to the U.S./Russian boundary, north of Umnak Island in the waters around of
14 Bogoslof Island. The distribution of pollock in the BSAI region varies seasonally with spawning
15 aggregations in the EBS and vicinity of Bogoslof Island, and then dispersion northward and westward to
16 cover the Bering Sea and Aleutian Basin.
17

18 Twenty-eight Steller sea lion rookeries and 49 major haulouts occur in this region (50 CFR, Tables 1 and
19 2 for part 226.12). Thus, Steller sea lions that may be affected by the pollock fishery haulout at
20 terrestrial sites from St. Matthew (haulout) and the Pribilof Islands (haulout and rookery sites) in the
21 north, and all along the Aleutian Chain from Amak Island and Sea Lion Rock in the southeastern Bering
22 Sea westward to the Commander Islands. Hill and DeMaster (1999) suggest a 1996 western population
23 of 39,500, of which about 56%, or just over 22,000, occurred in the BSAI region. The extent to which
24 sea lions from Russian territories (along the eastern shore of the Kamchatka peninsula) are affected by
25 the pollock fishery is uncertain. With the exception of no-trawl zones, the distribution of the fishery and
26 the distribution of foraging sea lions overlap extensively.
27

28 The action area for the GOA pollock fishery extends to the shelf break from the area south of Prince
29 William Sound to west of Umnak Island in the Aleutian Islands. The fishery is divided into eastern,
30 central, and western regions. The boundary between the eastern and central regions is at 147°W long.,
31 and essentially overlays the easternmost rookery and haulouts of the western population. The
32 management areas of primary concern are, therefore, the central and western regions. The central and
33 western regions are divided into three management areas, all of which extend from the 3-mile state
34 boundary to the EEZ limit. Area 630 is delimited on the east by 147°W long. and on the west by 154°W
35 long. Area 620 extends from 630 further west to 159°W long. and area 610 extends from 620 to 170°W
36 long. Within these three management areas, fishing is concentrated south of Unimak Pass and Island
37 (Davidson Bank), southeast and southwest of the Shumagin Islands, along the 200-fathom isobath
38 running from the shelf break northeastward to Shelikof Strait, Shelikof Strait, and the canyon regions east
39 of Kodiak Island.
40

41 The principle concern with the Pacific cod fishery in the BSAI and GOA is the possible competitive
42 interaction with the endangered western population of Steller sea lions. Over the last 20 years, there has
43 been a significant increase in the amount and relative percentage of Pacific cod removed by the fishery
44 from the action area designated as critical habitat for the western population of Steller sea lions. This
45 has been previously noted in two prior biological opinions on the groundfish fisheries (NMFS 1998 and
46 1999). In the BSAI, the harvest has occurred primarily in the winter period, and is especially true in the
47 Aleutian Islands (AI). For the Bering Sea, between 42 and 46% of the annual catch is taken inside
48 critical habitat. Of this about 35 to 36% has been taken in the winter period inside critical habitat, with

1 little being taken in each of the other seasons. In the AI, between 80 and 95% of the catch is taken in
2 critical habitat, of which about 60 to 75% is harvested inside critical habitat in the winter. In the GOA,
3 over the last four years, between 40 and 70% of the annual catch has been taken in critical habitat. Of
4 this about 47 to 68% has been taken in the winter period inside critical habitat. There is very little
5 directed effort for cod outside the winter seasons.
6

7 Commercial groundfish fisheries that are managed by the State of Alaska in the action area are
8 introduced in the *Environmental Baseline* section of this biological opinion. We expect those fisheries
9 and their effects to continue in the action area and into the future. Herring, salmon, Pacific cod, and
10 pollock, are fisheries that are managed entirely by the State of Alaska, or (in the case of Pacific cod) only
11 a percentage of the fishery is managed by State authority, and are species found year-round in the diet of
12 Steller sea lions. The Federal Pacific cod TACs in the GOA have been affected by a Pacific cod fishery
13 managed in state waters by the State of Alaska since 1998. In 1998 and 1999, the State cod fishery
14 occurred mostly in the winter and of that about 95% of the catch was in critical habitat. That is not
15 surprising since the State fishery is limited to within 3 nm of land and critical habitat is extended to 20
16 nm from rookeries and haulouts. For species such as salmon and herring, they occur much more
17 frequently in the summer as determined by analyses of scat samples from 1990-1998.
18

19 **3.1 Critical Habitat in the Action Area**

20
21 The proposed rule for establishment of critical habitat for the Steller sea lion was published on 1 April
22 1993 (58 FR 17181), and the final rule was published on 27 August 1993 (58 FR 45269). The following
23 areas have been designated as critical habitat in the action area.
24

- 25 (a) Alaska rookeries, haulouts, and associated areas. In Alaska, all major Steller sea lion
26 rookeries identified in 50 CFR, part 226.12, Table 1, and major haulouts identified in 50
27 CFR, part 226.12, Table 2, and associated terrestrial, air, and aquatic zones, have been
28 designated as critical habitat for the Steller sea lion. Critical habitat includes a terrestrial
29 zone that extends 3,000 feet (0.9 km) landward from the baseline or base point of each
30 major rookery and major haulout in Alaska. Critical habitat includes an air zone that
31 extends 3000 feet (0.9 km) above the terrestrial zone of each major rookery and major
32 haulout in Alaska, measured vertically from sea level. Critical habitat includes an
33 aquatic zone that extends 3,000 feet (0.9 km) seaward in State and Federally managed
34 waters from the baseline or basepoint of each major haulout in Alaska that is east of 144°
35 W long. Critical habitat includes an aquatic zone that extends 20 nm (37 km) seaward in
36 State and Federally managed waters from the baseline or basepoint of each major
37 rookery and major haulout in Alaska that is west of 144° W long.
38
- 39 (b) Three special aquatic foraging areas in Alaska, including the Shelikof Strait area, the
40 Bogoslof area, and the Segum Pass area.
- 41
42 (1) Critical habitat includes the Shelikof Strait area in the GOA which . . . consists
43 of the area between the Alaska Peninsula and Tugidak, Sitkinak, Aiaktulik,
44 Kodiak, Raspberry, Afognak and Shuyak Islands (connected by the shortest
45 lines): bounded on the west by a line connecting Cape Kumlik
46 (56°38"/157°26'W) and the southwestern tip of Tugidak Island
47 (56°24'/154°41'W) and bounded in the east by a line connecting Cape Douglas
48 (58°51'N/153°15'W) and the northernmost tip of Shuyak Island

1 (58°37'N/152°22'W).
2

- 3 (2) Critical habitat includes the Bogoslof area in the Bering Sea shelf which . . .
4 consists of the area between 170°00'W and 164°00'W, south of straight lines
5 connecting 55°00'N/170°00'W and 55°00'N/168°00'W; 55°30'N/168°00'W and
6 55°30'N/166°00'W; 56°00'N/166°00'W and 56°00'N/164°00'W and north of the
7 Aleutian Islands and straight lines between the islands connecting the following
8 coordinates in the order listed:
9

10 52°49.2'N/169°40.4'W; 52°49.8'N/169°06.3'W; 53°23.8'N/167°50.1'W;
11 53°18.7'N/167°51.4'W; 53°59.0'N/166°17.2'W; 54°02.9'N/163°03.0'W;
12 54°07.7'N/165°40.6'W; 54°08.9'N/165°38.8'W; 54°11.9'N/165°23.3'W;
13 54°23.9'N/164°44.0'W
14

- 15 (3) Critical habitat includes the Seguam Pass area which . . . consists of the area
16 between 52°00'N and 53°00'N and between 173°30'W and 172°30'W.
17

18 Prey resources are the most important feature of marine critical habitat. Marine areas may be used for a
19 variety of other reasons (e.g., social interaction, rafting or resting), but foraging is the most important sea
20 lion activity that occurs when the animals are at sea. Two kinds of marine habitat were designated as
21 critical. First, areas around rookeries and haulouts were chosen based on evidence that many foraging
22 trips by lactating adult females in summer may be relatively short (20 km or less; Merrick and Loughlin
23 1997). Also, mean distances for young-of-the-year in winter may be relatively short (about 30 km;
24 Merrick and Loughlin 1997). The availability of prey in the vicinity of rookeries and haulouts must be
25 crucial to their transition to independent feeding after weaning. Similarly, areas around rookeries are
26 likely to be important for juveniles. While the foraging patterns of juveniles have not been studied in the
27 BSAI region, it is possible that they depend considerably on resources close to haulouts. Therefore, the
28 areas around rookeries and haulouts must contain essential prey resources for at least lactating adult
29 females, young-of-the-year, and juveniles, and those areas were deemed essential to protect.
30

31 Second, three areas were chosen based on 1) at-sea observations indicating that sea lions commonly used
32 these areas for foraging, 2) records of animals killed incidentally in fisheries in the 1980s, 3) knowledge
33 of sea lion prey and their life histories and distributions, and 4) foraging studies. In 1980, Shelikof Strait
34 was identified as a site of extensive spawning aggregations of pollock in winter months. Records of
35 incidental take of sea lions in the pollock fishery in this region provide evidence that Shelikof Strait is an
36 important foraging site (Loughlin and Nelson 1986, Perez and Loughlin 1991). The southeastern Bering
37 Sea north of the Aleutian Islands from Unimak Island past Bogoslof Island to the Islands of Four
38 Mountains is also considered a site that has historically supported a large aggregation of spawning
39 pollock, and is also an area where sighting information and incidental take records support the notion that
40 this is an important foraging area for sea lions (Fiscus and Baines 1966, Kajimura and Loughlin 1988).
41 Finally, large aggregations of Atka mackerel are found in the area around Seguam Pass. These
42 aggregations have supported a fishery since the 1970s, and are in close proximity to a major sea lion
43 rookery on Seguam Island and a smaller rookery on Agligadak Island. Atka mackerel are an important
44 prey of sea lions in the central and western Aleutian Islands. Records of incidental take in fisheries also
45 indicate that the Seguam area is an important for sea lion foraging (Perez and Loughlin 1991).
46

47 Prey resources are not only the primary feature of Steller sea lion marine critical habitat, but they also
48 appear to determine the carrying capacity of the environment for Steller sea lions. The term

1 “environmental carrying capacity” is generally defined as the number of individuals that can be
2 supported by the resources available. Therefore, the concepts of critical habitat and environmental
3 carrying capacity are closely linked: critical habitat reflects the geographical extent of the environment
4 needed to recover and conserve the species.

1
2
3 **4 STATUS OF SPECIES**
4
5
6

7 NMFS has determined that the actions being considered in this biological opinion may affect the
8 following species⁶ and critical habitat that have been provided protection under the ESA of 1973 (16
9 U.S.C. 1531 *et seq.*):

Listed Species	Scientific Name	ESA Status
Blue Whale	<i>Balaenoptera musculus</i>	Endangered
Bowhead Whale	<i>Balaena mysticetus</i>	Endangered
Fin Whale	<i>Balaenoptera physalus</i>	Endangered
Humpback Whale	<i>Megaptera novaeangliae</i>	Endangered
Right Whale	<i>Balaena glacialis</i>	Endangered
Sei Whale	<i>Balaenoptera borealis</i>	Endangered
Sperm Whale	<i>Physeter macrocephalus</i>	Endangered
Steller Sea Lion (Western Population)	<i>Eumetopias jubatus</i>	Endangered
Steller Sea Lion (Eastern Population)	<i>Eumetopias jubatus</i>	Threatened
Chinook Salmon (Puget Sound)	<i>Oncorhynchus tshawytscha</i>	Threatened
Chinook Salmon (Lower Columbia River)	<i>Oncorhynchus tshawytscha</i>	Threatened
Chinook Salmon (Upper Columbia River Spring)	<i>Oncorhynchus tshawytscha</i>	Endangered
Chinook Salmon (Upper Willamette River)	<i>Oncorhynchus tshawytscha</i>	Threatened
Chinook Salmon (Snake River Spring/Summer)	<i>Oncorhynchus tshawytscha</i>	Threatened
Chinook Salmon (Snake River Fall)	<i>Oncorhynchus tshawytscha</i>	Threatened
Sockeye Salmon (Snake River)	<i>Oncorhynchus nerka</i>	Endangered
Steelhead (Upper Columbia River)	<i>Onchorynchus mykiss</i>	Endangered
Steelhead (Middle Columbia River)	<i>Onchorynchus mykiss</i>	Threatened
Steelhead (Lower Columbia River)	<i>Onchorynchus mykiss</i>	Threatened
Steelhead (Upper Willamette River)	<i>Onchorynchus mykiss</i>	Threatened
Steelhead (Snake River Basin)	<i>Onchorynchus mykiss</i>	Threatened
Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	Endangered
Steller's Eider ⁷	<i>Polysticta stelleri</i>	Threatened
Short-tailed Albatross*	<i>Phoebaotria albatrus</i>	Endangered
Spectacled Eider*	<i>Somateria fishcheri</i>	Threatened
Northern Sea Otter*	<i>Enhydra lutris</i>	Candidate
Designated critical habitat		
Steller's Eider*		
Steller sea lion		

7 In its definition of species, the ESA of 1973, as amended, includes the traditional biological species concept of the biological sciences and "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (16 USC 1532). NMFS uses the term *evolutionarily significant unit* as synonymous with *distinct population segment* and lists Pacific salmon accordingly. For the purposes of section 7 consultations, these are all "species."

* The short-tailed albatross, spectacled eider, and Steller's eider are under the jurisdiction of the U.S. Fish and Wildlife Service. For these three species, critical habitat has been proposed only for the Steller's eider (65 FR 13262). The northern sea otter has been proposed by USFWS as a candidate species (November 9, 2000; 65 FR 67343).

1
2 The short-tailed albatross, spectacled eider, and Steller's eider are under the jurisdiction of the U.S. Fish
3 and Wildlife Service (USFWS). A letter dated December 2, 1998 from the USFWS to Steven Pennoyer,
4 NMFS, Administrator, Alaska region, extends the USFWS 1997-1998 biological opinion covering these
5 species until it is superseded by a subsequent amendment to that opinion. The USFWS issued a
6 Biological Opinion on March 19, 1999 concluding that the GOA and BSAI hook-and-line fisheries for
7 1999 and 2000 were not likely to jeopardize the continued existence of the short-tailed albatross. In
8 November 1999, NMFS requested that the USFWS affirm its determination that the ongoing groundfish
9 fisheries (all gear types) of the BSAI and GOA do not adversely affect the spectacled eider or the
10 Steller's eider. The USFWS has indicated the need for additional information regarding the relationship
11 between the BSAI and GOA groundfish fisheries and eider habitat to address the NMFS request. Given
12 that the Incidental Take Statement and Biological Opinion issued by the USFWS on March 19, 1999 will
13 expire December 31, 2000, NMFS is reinitiating section 7 consultation with the USFWS on all ESA
14 listed bird species.
15

16 NMFS also recognizes that gray whales (*Eschrichtius robustus*) migrate through the action area during
17 their spring and fall migrations toward the Chukchi and Beaufort Seas. Although gray whales were
18 removed from the list of threatened and endangered species in 1994 (59 FR 31094), NMFS has continued
19 to monitor the status of this species pursuant to Section 4(g) of the ESA and has conducted a monitoring
20 program for gray whales along the U.S. coast and in Mexican waters in cooperation with the government
21 of Mexico. This biological opinion will not assess whether the fisheries and FMPs are likely to
22 jeopardize the continued existence of gray whales; however, this opinion will include a general
23 assessment of the potential effects of the FMPs on gray whales as part of NMFS continuing efforts to
24 monitor the status of the species.
25

26 The narratives that follow summarize information on the biology of these threatened and endangered
27 species. More detailed information on the range-wide status and trends of these species and a critical
28 habitat can be found in recent sea turtle status documents (NMFS and USFWS 1995), recovery plans for
29 the blue whale (NMFS 1998a), humpback whale (NMFS 1991a), right whale (NMFS 1991b), Steller sea
30 lion (NMFS 1992), and leatherback sea turtle (NMFS and USFWS 1998), draft recovery plan for the fin
31 whale and sei whale (NMFS 1998b), the marine mammal stock assessment reports (Hill et al. 1997, Hill
32 and DeMaster, 1999), a status review of bowhead whales (Sheldon and Rugh 1995), and a status report
33 on six whale species that was prepared by Perry et al. (1999). Detailed information on range-wide status
34 and trends of listed salmon can be found in Waples et al. (1991a, 1991b), Burgner (1991), Healey (1991),
35 and Matthews and Waples (1991).
36

37 **4.1 Blue Whale**

38 39 **4.1.1 Species description and distribution** 40

41 Blue whales are the largest living mammal species. They may measure over 30 meters in length and
42 weigh up to 160 metric tons (Mackintosh 1942). They are blue-gray in color with distinct gray and white
43 mottling, while their ventral surface may be light pink in coloration. Their dorsal fin is relatively small.
44 Like other baleen whales, they have fringed baleen plates instead of teeth, and ventral grooves which
45 filter large quantities of water during feeding. Blue whales are found in all major oceans, including the
46 continental shelf in coastal shelves and far offshore in pelagic environments of the North Pacific (Rice
47 1974, Donovan 1984).
48

49 At least three subspecies of blue whales have been designated, but only one (*B. m. musculus*) occurs in

1 the northern hemisphere. In addition to these subspecies, the International Whaling Commission's (IWC)
2 Scientific Committee has formally recognized one blue whale stock in the North Pacific (Donovan,1991),
3 although there is increasing evidence that more than one stock occurs in the Pacific Ocean (Gilpatrick *et*
4 *al.* 1997, Barlow *et al.* 1995, Mizroch *et al.* 1984a, Ohsumi and Wada 1974). In the action area, blue
5 whales have been reported from the GOA to the Aleutian Islands, although blue whales have not been
6 sighted in the action area since 1978. Blue whales calls have been recorded in Alaskan waters from 1995
7 to 1999 in every season although the whales have not been seen. Most of these calls occurred in fall and
8 winter in the GOA suggesting that some blue whales remain in the action area (as opposed to migrating
9 through it).

11 **4.1.2 Life history information**

13 Blue whale reproductive activities occur primarily in winter (see Yochem and Leatherwood 1985).
14 Gestation takes 10–12 months, followed by a nursing period that continues for about 6–7 months. They
15 reach sexual maturity at about 5 years of age (see Yochem and Leatherwood 1985). The age distribution
16 of blue whales is unknown and little information exists on natural sources of mortality (such as disease)
17 and mortality rates. Killer whales are known to attack blue whales, but the rate of these attacks or their
18 effect on blue whale populations is unknown.

19
20 The species *Thysanoëssa inermis*, *Thysanoëssa longipes*, *Thysanoëssa raschii*, and *Nematoscelis*
21 *megalops* have been listed as prey of blue whales in the North Pacific (Kawamura 1980; Yochem and
22 Leatherwood 1985). Although some stomachs of blue whales have been found to contain a mixture of
23 euphausiids and copepods or amphipods (Nemoto 1957; Nemoto and Kawamura 1977), it is likely that
24 the copepods and amphipods were consumed adventitiously or incidentally. One exception to their near-
25 total dependence on euphausiid prey is that blue whales have been observed feeding on pelagic red crabs,
26 *Pleuroncodes planipes*, off Baja California (Rice 1974, 1986a), although these observations have not
27 been confirmed by subsequent observations or other analyses (e.g., fecal analysis). Reports that blue
28 whales feed on small, schooling fish and squid in the western Pacific (Mizue 1951; Sleptsov 1955) have
29 been interpreted as suggesting that the zooplankton blue whales prefer are less available there (Nemoto
30 1957). Between February and April, blue whales in the Gulf of California, Mexico, have been observed
31 feeding on euphausiid surface swarms (Sears 1990) consisting mainly of *Nyctiphanes simplex* engaged in
32 reproductive activities (Gendron 1990, 1992). Sears (1990) regarded *Nyctiphanes simplex* as the principal
33 prey of blue whales in the region, and results from recent fecal analyses confirmed this assertion
34 (Gendron and Del Angel-Rodriguez 1997). However, this phenomenon appears to be strongly influenced
35 by the occurrence of El Niño Southern Oscillation (ENSO) events (Gendron and Sears 1993).

36
37 Other baleen whales whose range overlaps with the range of blue whales could potentially compete with
38 blue whales for food (Nemoto 1970). However, there is no evidence of competition and the highly
39 migratory behavior of blue whales may help them avoid competition with other baleen whales (Clapham
40 and Brownell 1996).

42 **4.1.3 Listing status**

44 Blue whales have been listed as endangered under the ESA since 1973. They are also protected by the
45 Convention on International Trade in Endangered Species of wild flora and fauna and the Marine
46 Mammal Protection Act of 1972. The North Pacific stock is also listed as “low risk, conservation
47 dependent” under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical
48 habitat has not been designated for blue whales.

1 **4.1.4 Population status and trends**
2

3 There are no reliable estimates of blue whale abundance in the North Pacific Ocean or the action area.
4 Nevertheless, Gambell (1976) estimated there were about 4,900 blue whales in the North Pacific before
5 whaling began. Gambell (1976) also estimated there were about 1,600 blue whales in the North Pacific in
6 the 1990s (with a range of 1,400 to 1,900). Wade and Gerrodette (1993) and Barlow et al. (1997, as cited
7 in Perry *et al.* 1999) estimated there were a minimum of 3,300 blue whales in the North Pacific Ocean in
8 the 1990s.
9

10 **4.1.5 Impacts of human activity on the species**
11

12 From 1889 to 1965 approximately 5,761 blue whales were taken from the North Pacific Ocean (NMFS
13 1998a). Evidence of a population decline can be seen in the catch data from Japan. In 1912, 236 blue
14 whales were caught, in 1913, 58 whales, in 1914, 123 whales, and from 1915 to 1965, the catch numbers
15 declined continuously (Mizroch *et al.* 1984a). In the eastern North Pacific, 239 blue whales were taken
16 off the California coast in 1926. And, in the late 1950s and early 1960s, Japan caught 70 blue whales per
17 year off the Aleutian Islands (Mizroch *et al.* 1984a).
18

19 The IWC banned commercial whaling in the North Pacific in 1966, since that time there have been no
20 reported blue whale takes. Nevertheless, Soviet whaling probably continued after the ban so Soviet catch
21 reports under-represent the number of blue whales killed by whalers (as cited in Forney and Brownell
22 1996). Surveys conducted in these former whaling areas in the 1980s and 1990s failed to find any blue
23 whales (Forney and Brownell 1996).
24

25 There are no reports of fisheries-related mortality or serious injury in any of the blue whale stocks. Blue
26 whale interaction with fisheries may go undetected because the whales are not observed after they swim
27 away with a portion of the net. However, fishers report that large blue and fin whales usually swim
28 through their nets without entangling and with very little damage to the net (Barlow *et al.* 1997).
29

30 **4.1.5.1 Vessel traffic and noise disturbance**
31

32 In 1980, 1986, 1987, and 1993, ship strikes have been implicated in the deaths of blue whales off
33 California (Barlow *et al.* 1997). In addition, several photo-identified blue whales from California
34 waters were observed with large scars on their dorsal areas that may have been caused by ship
35 strikes. Studies have shown that blue whales respond to approaching ships in a variety of ways,
36 depending on the behavior of the animals at the time of approach, and speed and direction of the
37 approaching vessel. While feeding, blue whales react less rapidly and with less obvious
38 avoidance behavior than whales that are not feeding (Sears *et al.* 1983). Within the St. Lawrence
39 Estuary, blue whales are believed to be affected by large amounts of recreational and commercial
40 vessel traffic. Blue whales in the St. Lawrence appeared more likely to react to these vessels
41 when boats made fast, erratic approaches or sudden changes in direction or speed (Edds and
42 Macfarlane 1987, Macfarlane 1981).
43

44 The number of blue whales struck and killed by ships is unknown because the whales do not
45 always strand or examinations of blue whales that have stranded did not identify the traumas that
46 could have been caused by ship collisions. In the California/Mexico stock, annual incidental
47 mortality due to ship strikes averaged 0.2 whales during 1991–1995 (Barlow *et al.* 1997), but we
48 cannot determine if this reflects the actual number of blue whales struck and killed by ships.
49

1 Blue whales do not appear to be disturbed by noise from seismic exploration. When noise pulses
2 from air guns were produced off Oregon, blue whales continued vocalizing at the same rate as
3 before the pulses, suggesting that at least their vocalization behavior was undisturbed by the
4 noise (McDonald *et al.* 1993).

5 6 **4.2 Bowhead Whale**

7 8 **4.2.1 Species description and distribution**

9
10 Bowhead whales were historically found in all Arctic waters of the northern hemisphere. For
11 management purposes, the IWC recognizes five stocks or populations of bowhead whales: Spitsbergen,
12 Davis Strait, Hudson Bay, Okhotsk, and western Arctic (IWC 1992). This summary will focus on the
13 two stocks that occur in the North Pacific Ocean: the Okhotsk Sea stock and western Arctic stocks.

14
15 The Okhotsk Sea stock occurs in the North Pacific off the western coast of Siberia near the Kamchatka
16 Peninsula. The pre-exploitation size of this stock may have been 3,000–6,500 animals (Shelden and
17 Rugh 1995), and may now number somewhere in the 300–400 range, although reliable population
18 estimates are not currently available. This stock may mix with the Bering Sea stock (or may have mixed
19 in the past), although the available evidence indicates the two stocks are essentially separate.

20
21 The western Arctic stock, which is also called the Bering Sea stock or Bering-Chukchi-Beaufort stock,
22 has been studied more extensively than any other bowhead whale stock. From November to April, the
23 Bering Sea stock of bowhead whales is widely distributed in the central and western Bering Sea in
24 association with the marginal ice front and near the polynyas of St. Matthew Island, St. Lawrence Island,
25 and the Gulf of Anadyr (Braham *et al.* 1982).

26
27 About April or May, most of the whales in this population begin moving north past St. Lawrence Island
28 and through the Bering Strait into the southern Chukchi Sea, then north through nearshore lead systems
29 to Point Barrow. Bowhead whales pass Point Barrow in several “pulses”: the first between late April and
30 early May, a second about mid-May, and a third from late May through early June. Whaling crews also
31 have noticed that some bowhead whales remain near Barrow during the summer and apparently do not
32 migrate to the Canadian Beaufort Sea or waters off Siberia.

33
34 Most whales move eastward from Point Barrow through offshore lead systems of the central Beaufort
35 Sea. Bowhead whales arrive in the Canadian Beaufort Sea from about mid-May through mid-June where
36 they concentrate between Herschel Island and Amundsen Gulf. Whales begin moving back westward
37 between late August and early October. The fall migration generally occurs south of the pack ice and
38 closer inshore than the spring migration. Data are limited on the bowhead fall migration through the
39 Chukchi Sea before they move south into the Bering Sea. After moving south through the Chukchi Sea,
40 bowhead whales pass through the Bering Strait in late October through early November on their way to
41 overwintering areas in the Bering Sea.

42 43 **4.2.2 Life history information**

44
45 Little is known about when bowhead whales become sexually mature, their mating behavior, and the
46 timing of their reproductive activity. Most investigators have assumed that bowhead whales mate during
47 late winter and spring, perhaps continuing through the spring migration. Most calves are born from April
48 through early June during the spring migration, with a few calves born as early as March and as late as
49 August (Koski *et al.* 1993). Calves are about 13 to 15 ft (4 to 4.5 m) at birth and reach 42 to 66 ft (13 to

1 20 m) as adults. Females produce a single calf, probably every 3 to 4 years .

2
3 Bowhead whales appear to feed primarily during the summer. Like other baleen whales, bowhead whales
4 are filter-feeders that sieve prey from the water through baleen fibers in their mouths. They feed almost
5 exclusively on zooplankton, with primary prey consisting of copepods (54%) and euphausiids (42%).
6 Other prey include mysids, hyperiid and gammarid amphipods, other pelagic invertebrates, and small
7 fish. Bowhead whales feed heavily in the Canadian Beaufort Sea and Amundsen Gulf area during
8 summer and fall migration through the Alaskan Beaufort Sea. Carbon isotope analysis of bowhead
9 baleen has indicated that a significant amount of feeding may occur in wintering areas of the Chukchi
10 and Bering Seas. During the feeding season, bowhead whales consume about 3 or 4 percent of their body
11 weight per day or about 2.0 tons of food (Lowry et al. 1982).

12
13 The summer distribution of bowhead whales within the Beaufort Sea is determined primarily by prey
14 density and distribution, which in turn reflect variable current and upwelling patterns. Sub-adult
15 bowhead whales were observed to feed in water depths less than 164 ft (50 m) in the Canadian Beaufort
16 Sea. However, little is known about the feeding behavior of adult bowhead whales in the Canadian
17 Beaufort Sea.

18
19 Little is known about disease and natural causes of death among bowhead whales. While certain viral
20 agents are present in this stock, their contribution to natural mortality or reduced reproduction is
21 unknown. Some bowhead whales appear to become trapped by ice and die as a result although the
22 percentage of whales entrapped in ice is considered to be small, given that bowhead whales are so
23 strongly associated with sea ice (Tomilin 1957). Bowhead whales are also killed by killer whales
24 (*Orcinus orca*), which are the bowhead's only known natural predator. Of 195 whales examined during
25 Alaskan subsistence harvests (1976-1992), 8 had been wounded by killer whales. Seven of the eight
26 bowhead whales were greater than 13 m in length, suggesting either that scars are accumulated over time,
27 or young animals do not survive a killer whale attack. Hunters on St. Lawrence Island reported two small
28 (<9 m) bowhead whales found dead as a result of killer whale attacks.

30 **4.2.3 Listing status**

31
32 In 1964, the IWC began to regulate commercial whaling worldwide, which benefitted bowhead whales.
33 Bowhead whales were listed as endangered in 1970 under the predecessor to the ESA of 1973. They are
34 also protected by the Convention on International Trade in Endangered Species of wild flora and fauna
35 and the Marine Mammal Protection Act of 1972. Critical habitat has not been designated in the action
36 area, although NMFS is currently evaluating a petition to designate the U.S. Beaufort Sea as critical
37 habitat for the bowhead whale.

39 **4.2.4 Population status and trends**

40
41 The Bering Sea stock of bowhead whales was reduced greatly by commercial whaling in the late 19th
42 and early 20th centuries. The pre-whaling stock has been estimated at 10,400 to 23,000 (Woodby and
43 Botkin 1993), but was reduced by whaling to a few thousand animals by 1910. Whales taken in the
44 Bering Sea may have been representatives of a population that did not migrate. Based on shore-based
45 surveys from 1978 through 1983, the bowhead whale population size was estimated to be between 3,500
46 to 5,300 animals (Zeh et al. 1993). The IWC Scientific Committee estimates the current size of the
47 Bering Sea stock of bowhead whales as 7,992 whales (95% C.I.: 6,900–9,200; IWC 1995). A refined and
48 larger sample of acoustic data from 1993 has resulted in an estimate of 8,200 animals and is considered a
49 better estimate for this stock (Hill et al. 1997). The Bering Sea stock of bowhead whales is believed to

1 be increasing at an annual rate of 3.1%.
2

3 **4.2.5 Impacts of human activity on the species** 4

5 The Bering Sea stock of bowhead whales is hunted by the Natives of the Alaskan Beaufort, Bering, and
6 Chukchi Seas for cultural and subsistence purposes. Since 1978, the IWC has imposed a quota on the
7 number of bowhead whales landed and/or struck by Alaskan natives. The IWC recently allocated the
8 subsistence take of bowhead whales from the Alaska stock, establishing a 5-year block quota of 280
9 whales landed. For each of the years 1998–2002, the number of bowhead whales struck may not exceed
10 67 animals, except that unused quotas may be carried over to subsequent years. In addition, an annual
11 quota of five bowhead whales has been granted to the Russian Federation for the Natives of Chukotka.
12

13 The number of whales landed in the subsistence harvest of bowhead whales from 1978–1991 ranged
14 from a low of 8 in 1982 to a high of 30 in 1990 and averaged 18 whales per year. From 1991 to 1995, a
15 combined average of 19 bowhead whales per year were taken by the communities of Barrow, Nuiqsut,
16 and Kaktovik. In 1998, 41 bowhead whales were landed and 12 were struck and lost during the spring
17 and fall harvests, while in 1999, 42 whales were landed and 5 were struck and lost.
18

19 Commercial fishing occurs in the Bering Sea and elsewhere within the range of this stock. Evidence of
20 interactions between bowhead whales and fishing gear is rare, although bowhead whales have been
21 reported with ropes caught in their baleen and with scarring caused by rope entanglement. We have no
22 records of bowhead whales being captured, seriously injured, or killed by fishing gear in U.S. waters
23 (Small and DeMaster 1995), although a young bowhead whale was apparently entrapped and killed in a
24 fishing net in Japan (Nishiwaki and Kasuya 1970). Bowhead whales are also struck and injured by ships,
25 although these incidents do not appear to be common (George et al. 1994). Man-made noise in the
26 marine environment is increasing with industrialization of the Alaskan arctic, and may affect bowhead
27 whales. Despite many years of study, the seriousness of those effects on bowhead whales is unknown.
28

29 **4.3 Fin Whale**

30 **4.3.1 Species description and distribution** 31

32 Fin whales are distributed widely in the world's oceans. In the northern hemisphere, most migrate
33 seasonally from high Arctic feeding areas in summer to low latitude breeding and calving areas in winter.
34 Other groups may remain year-round in a particular area, depending on food supply. The IWC's
35 Scientific Committee recognizes two management stocks in the North Pacific: (1) the east China Sea, and
36 (2) the rest of the North Pacific (Donovan, 1991). Mizroch et al. (1984b) suggested five possible stocks
37 within the North Pacific based on histological and tagging experiments (1) east and west Pacific that
38 intermingle around the Aleutian Islands; (2) east China Sea; (3) British Columbia; (4) southern/central
39 California to the GOA; and (5) Gulf of California (Rice 1974, Tershy et al. 1993). However, NMFS
40 considers stock structure in the North Pacific to be equivocal, and recognizes three stocks: (1) Alaska
41 (northeast Pacific), (2) California/Oregon/ Washington, and (3) Hawaii (Barlow et al. 1997, Hill and
42 DeMaster 1998).
43
44

45 Fin whales were reported as occurring immediately offshore throughout the North Pacific from central
46 Baja California to Japan and as far north as the Chukchi Sea (Rice 1974). Fin whales occurred in high
47 densities in the northern GOA and southeastern Bering Sea from May to October, with some movement
48 through the Aleutian passes into and out of the Bering Sea (Reeves et al. 1985). Fin whales were
49 observed and taken by Japanese and Soviet whalers off eastern Kamchatka and Cape Navarin, both north

1 and south of the eastern Aleutians, and in the northern Bering and southern Chukchi seas (Berzin and
2 Rovnin 1966, Nasu 1974). In 1999, vessel surveys of the central Bering Sea reported 75 fin whale
3 sightings (346 whales) clustered along the outer Bering Sea shelf break, primarily near the 200m isobath
4 (Moore et al. 2000). In the GOA, fin whales appear to congregate in the waters around Kodiak Island
5 and south of Prince William Sound.

6
7 In recent years, small numbers of fin whales have been observed south of the Aleutian Islands (Forney
8 and Brownell 1996), in the GOA (including Shelikof Strait), and in the southeastern Bering Sea
9 (Leatherwood et al. 1986). Their regular occurrence has also been noted in recent years around the
10 Pribilof Islands in the northern Bering Sea (Baretta and Hunt 1994). Fin whale concentrations in the
11 northern areas of the North Pacific and Bering Sea generally form along frontal boundaries, or mixing
12 zones between coastal and oceanic waters, which themselves correspond roughly to the 200-m isobath
13 (which is the shelf edge; Nasu 1974).

14
15 Acoustic data collected from 1995 to 1999 from hydrophone arrays showed fin whales vocalizing in
16 Alaskan waters during all seasons, with a peak in occurrence in midwinter.

17 **4.3.2 Life history information**

18
19 Fin whales become sexually mature between six to ten years of age, depending on density-dependent
20 factors (Gambell 1985b). Reproductive activities for fin whales occur primarily in the winter. Gestation
21 lasts about 12 months and nursing occurs for 6-11 months (Perry et al. 1999). The age distribution of fin
22 whales in the North Pacific is unknown.

23
24 Fin whales in the North Pacific feed on euphausiids, calanoid copepods, and schooling fish such as
25 herring, pollock, Atka mackerel, and capelin (Calkins 1986; Nemoto 1957, 1970; Kawamura 1982).
26 Euphausiids may be preferred prey, and competition may occur with other baleen whales or other
27 consumers of these prey types.

28
29 Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest
30 annual natural mortality rates may range between 0.04 and 0.06 (based on studies of northeast Atlantic
31 fin whales). The occurrence of the nematode, *Crassicauda boopis*, appears to increase the potential for
32 kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling
33 (Lambertsen 1992, as cited in Perry et al. 1999). Killer whale or shark attacks may result in serious
34 injury or death in very young and sick whales (Perry et al. 1999). NMFS has no records of fin whales
35 being killed or injured by commercial fisheries operating in the North Pacific (Ferrero et al. 2000).

36 37 **4.3.3 Listing status**

38
39 In the North Pacific, the IWC began management of commercial whaling for fin whales in 1969; fin
40 whales were fully protected from commercial whaling in 1976 (Allen 1980). Fin whales were listed as
41 endangered under the ESA. They are also protected by the Convention on International Trade in
42 Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Fin whales
43 are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996).
44 Critical habitat has not been designated for fin whales.

45 46 **4.3.4 Population status and trends**

47
48 Prior to exploitation by whaling vessels, the North Pacific population consisted of an estimated
49

1 42,000–45,000 fin whales (Ohsumi and Wada 1974). Between 1914 and 1975, over 26,040 fin whales
2 were harvested throughout the North Pacific (in Perry et al. 1999). Catches in the North Pacific and
3 Bering Sea ranged from 1,000 to 1,500 fin whales annually during the 1950's and 1960's. However, not
4 all Soviet catches were reported (cited in Ferrero et al. 2000). In the early 1970s, the entire North Pacific
5 population had been reduced to between 13,620 and 18,630 fin whales (Ohsumi and Wada 1974).
6 During the early 1970s, 8,520–10,970 fin whales were surveyed in the eastern half of the North Pacific
7 (Braham 1991). If these historic estimates are statistically reliable, the population size of fin whales has
8 not increased significantly over the past 20 years despite an international ban on whaling in the North
9 Pacific.

10
11 The current status and trend of the fin whale population in the North Pacific is largely unknown. Based
12 on the available information, it is feasible that the North Pacific population as a whole has failed to
13 increase significantly over the past 20 years, despite an international ban on whaling in the North Pacific.
14 The only contrary evidence comes from investigators conducting seabird surveys around the Pribilof
15 Islands in 1975-1978 and 1987-1989. These investigators observed more fin whales in the second survey
16 and suggested they were more abundant in the survey area (Baretta and Hunt 1994). A survey for whales
17 in the central Bering Sea in 1999 tentatively estimated the fin whale population was about 4,951 animals
18 (95% C.I.: 2,833-8,653).

19 20 **4.3.5 Impacts of human activity on this species**

21
22 As early as the mid-seventeenth century, the Japanese were capturing fin, blue, and other large whales
23 using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982, Cherfas 1989). In
24 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the
25 large-scale exploitation of previously unobtainable whale species. The North Pacific and Antarctic
26 whaling operations soon added this ‘modern’ equipment to their arsenal. After blue whales were
27 depleted in most areas, the smaller fin whale became the focus of whaling operations and more than
28 700,000 fin whales were landed in the twentieth century.

29
30 In the North Pacific, there are no reports of fin whale deaths caused by fishery-related activities (Hill et
31 al. 1997), although conflicts between fin whales and drift gillnet fisheries may occur (Barlow et al.
32 1997). Because of their size, strength, and distribution, it would probably be difficult to assess potential
33 interactions between fin whales and fisheries; for example, fishermen have reported that large blue and
34 fin whales usually swim through their nets without entangling and with very little damage to the net
35 (Barlow et al. 1997).

36 37 **4.4 Humpback Whale**

38 39 **4.4.1 Species description and distribution**

40
41 NMFS recognizes four stocks of humpback whales in the North Pacific, two of which are pertinent to this
42 consultation: one in the central North Pacific and one in the western North Pacific (Hill and DeMaster
43 1998). The primary distinguishing pattern for these two stocks is their wintering ground: the western
44 North Pacific unit winters south of the Japanese archipelago, whereas the central North Pacific unit
45 winters in the waters around Hawaii. The summer range of the western North Pacific unit is poorly
46 studied, but almost certainly overlaps to some degree with that of the central North Pacific unit.

47
48 Humpback whales also summer throughout the central and western portions of the GOA, including
49 Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and

1 along the southern coastline of the Alaska Peninsula. Japanese scouting vessels continued to observe
2 high densities of humpback whales near Kodiak Island during 1965–1974 (Wada 1980). In Prince
3 William Sound, during recent years [i.e., prior to 1991], humpback whales have congregated near Naked
4 Islands, in Perry Passage, near Cheega Island, in Jackpot, Icy and Whale Bays, in Port Bainbridge and
5 north of Montague Islands between Green Island and the Needle (Hall 1979, 1982; von Ziegesar 1984;
6 von Ziegesar and Matkin 1986). The few sightings of humpback whales in offshore waters of the central
7 GOA are usually attributed to animals migrating into coastal waters (Morris et al. 1983), although use of
8 offshore banks for feeding is also suggested.

9
10 The continental shelf of the Aleutian Islands and Alaska Peninsula were once considered the center of the
11 North Pacific humpback whale population (Berzin and Rovnin 1966; Nishiwaki 1966). The northern
12 Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula appear to form the
13 northern extreme of the humpback whale’s range (Nikulin 1946, Berzin and Rovnin 1966). However,
14 sightings of humpback whales in the Bering Sea were most frequent south of Nunivak Island and east of
15 the Pribilof Islands (Berzin and Rovnin 1966; Braham et al. 1977; Nemoto 1978; Braham et al. 1982;
16 Leatherwood *et al.* 1983).

17 18 **4.4.2 Life history information**

19
20 Humpback whale reproductive activities occur primarily in winter. They become sexually mature at age
21 four to six. Annual pregnancy rates have been estimated at about 0.40–0.42 (NMFS unpublished and
22 Nishiwaki 1959) and female humpback whales are believed to become pregnant every two to three years.
23 Cows will nurse their calves for up to 12 months. The age distribution of the humpback whale
24 population is unknown, but the portion of calves in various populations has been estimated at about
25 4–12% (Chittleborough 1965, Whitehead 1982, Bauer 1986, Herman et al. 1980, and Clapham and Mayo
26 1987). The information available does not identify natural causes of death among humpback whales or
27 their number and frequency over time, but potential causes of natural mortality are believed to include
28 parasites, disease, predation (killer whales, false killer whales, and sharks), biotoxins, and entrapment in
29 ice.

30
31 Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types
32 including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North
33 Pacific include herring, anchovy, capelin, pollock, Atka mackerel, eulachon, sand lance, pollack, Pacific
34 cod, saffron cod, arctic cod, juvenile salmon, and rockfish. In the waters west of the Attu Islands and
35 south of Amchitka Island, Atka mackerel were preferred prey of humpback whales (Nemoto 1957).
36 Invertebrate prey include euphausiids, mysids, amphipods, shrimps, and copepods.

37 38 **4.4.3 Listing status**

39
40 The IWC first protected humpback whales in the North Pacific in 1965. Humpback whales were listed as
41 endangered under the ESA in 1973. They are also protected by the Convention on International Trade in
42 Endangered Species of wild flora and fauna and the Marine Mammal Protection Act of 1972. Critical
43 habitat has not been designated for the species.

44 45 **4.4.4 Population status and trends**

46
47 An estimated 394 humpback whales constitute the western North Pacific stock (Calambokidis et al.
48 1997). Waite et al. (1999) identified 127 individual humpback whales in the Kodiak Island region
49 between 1991 and 1994 and estimated there were 651 whales in this region (95% CI:356-1,523). Waite

1 et al. (1999) also estimated that 200 humpback whales regularly feed in Prince William Sound.
2 Subsequently, based on mark-recapture analysis of photo-identification studies, several investigators
3 concluded that the central North Pacific stock consists of at least 4,000 humpback whales (Calambokidis
4 et al. 1997, Ferrero et al. 2000). Other than these estimates of the size of the humpback whale
5 population, the available information is not sufficient to determine population trends.
6

7 In the BSAI, the humpback whale population was dramatically reduced by commercial whaling (see the
8 discussion of commercial whaling in the Environmental Baseline chapter). The humpback whale
9 population is believed to have increased since whaling ceased, although the rate of increase is unknown.
10 Brueggeman et al. (1987) did not sight humpback whales in the North Aleutian and St. George Basin
11 Outer Continental Shelf planning areas to the north and west of the Alaska Peninsula. Similarly, Stewart
12 et al. (1987) did not observe humpback whales during aerial surveys on or near areas hunted by vessels
13 from the Akutan whaling station in the eastern Aleutians. Braham et al. (1977) saw 14 humpback whales
14 in the northern Bering Sea in August 1976, and Braham et al. (1982) documented 25 humpback whales
15 between 1958 and 1978 between Unimak Pass and the Pribilof Islands in the southern Bering Sea.
16

17 **4.4.5 Impacts of human activity on the species**

18

19 In the 1990s, no more than 3 humpback whales were killed annually in U.S. waters by commercial
20 fishing operations in the Atlantic and Pacific Oceans. Between 1990 and 1997, no humpback whale
21 deaths have been attributed to interactions with groundfish trawl, longline and pot fisheries in the BSAI,
22 and GOA (Hill and DeMaster 1999). Humpback whales have been injured or killed elsewhere along the
23 mainland U.S. and Hawaii (Barlow et al. 1997). In 1991, a humpback whale was observed entangled in
24 longline gear and released alive (Hill et al. 1997). In 1995, a humpback whale in Maui waters was found
25 trailing numerous lines (not fishery-related) and entangled in mooring lines. The whale was successfully
26 released, but subsequently stranded and was attacked and killed by tiger sharks in the surf zone. In 1996,
27 a humpback whale calf was found stranded on Oahu with evidence of vessel collision (propeller cuts;
28 NMFS unpub. data). Also in 1996, a vessel from Pacific Missile Range Facility in Hawaii rescued an
29 entangled humpback, removing two crabpot floats from the whale; the gear was traced to a recreational
30 fisherman in southeast Alaska. No information is available on the number of humpback whales that have
31 been killed or seriously injured by interactions with fishing fleets outside of U.S. waters in the North
32 Pacific Ocean.
33

34 Humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing
35 vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989, Clapham et al. 1993,
36 Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size,
37 composition, and behavior of the whales when the noises occurred (Herman et al. 1980, Watkins et al.
38 1981, Krieger and Wing 1986). Several investigators have suggested that noise may have caused
39 humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979b, Dean et al. 1985),
40 while others have suggested that humpback whales may become habituated to vessel traffic and its
41 associated noise. Still other researchers suggest that humpback whales may become more vulnerable to
42 vessel strikes once they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995). In Hawaii,
43 regulations prohibit boats from approaching within 91 m of adult whales and within 274 m in areas
44 protected for mothers with a calf. Likewise, in Alaska, the number of cruise ships entering Glacier Bay
45 has been limited to reduce possible disturbance.
46

47 Many humpback whales are killed by ship strikes along both coasts of the U.S. On the Pacific coast, a
48 humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). On the Atlantic
49 coast, 6 out of 20 humpback whales stranded along the mid-Atlantic coast showed signs of major ship

1 strike injuries (Wiley et al. 1995). Almost no information is available on the number of humpback
2 whales killed or seriously injured by ship strikes outside of U.S. waters.

4 4.5 Right Whale

6 4.5.1 Species description and distribution

8 Right whales have occurred historically in all the world's oceans from temperate to subarctic latitudes. The
9 IWC currently recognizes two species of northern right whales: *Eubalaena glacialis* in the North Atlantic
10 and *E. japonica* in the North Pacific. However, right whales in the North Atlantic, North Pacific, and the
11 southern hemisphere of both oceans are currently listed under the ESA as one species: right whales (which
12 includes *E. glacialis*, *E. japonica*, and *E. australis*). For the purposes of ESA Section 7(a)(2) consultations,
13 NMFS recognizes three major populations of right whales: North Pacific, North Atlantic, and Southern
14 Hemisphere. The available information is not sufficient to identify stocks in the North Pacific, although
15 Scarff (1986) suggested a right whale stock may be associated with the GOA.

16
17 Very little is known of the size and distribution of right whales in the North Pacific and very few of these
18 animals have been seen in the past 20 years. In 1996, a group of 3–4 right whales (which may have included
19 a calf) were observed in the middle shelf of the Bering Sea, west of Bristol Bay and east of the Pribilof
20 Islands (Goddard and Rugh 1998). In June 1998, a lone whale was observed on historic whaling grounds
21 near Albatross Bank off Kodiak Island, Alaska (Waite and Hobbs 1999). Surveys conducted in July of
22 1997–2000 in Bristol Bay reported observations of lone animals or small groups of right whales in the same
23 area as the 1996 sighting (Hill and DeMaster 1998, Perryman et al. 1999). Historical whaling records
24 (Maury 1852, Townsend 1935, Scarff 1986) indicate the right whale ranged across the North Pacific above
25 35°N lat. They summered in the North Pacific Ocean and southern Bering Sea from April or May to
26 September, with a peak in sightings in coastal waters of Alaska in June and July (Maury 1852, Townsend
27 1935, Omura 1958, Klumov 1962, Omura et al. 1969). Their summer range extended north of the Bering
28 Strait (Omura *et al.* 1969). However, they were particularly abundant in the GOA from 145° to 151°W
29 (Berzin and Rovnin, 1966), and apparently concentrated in the GOA, especially south of Kodiak Islands and
30 in the Eastern Aleutian Islands and southern Bering Sea shelf waters (Braham and Rice, 1984).

31
32 The winter distribution patterns of right whales in the Pacific are virtually unknown, although some right
33 whales have been sighted as far south as 27°N in the eastern North Pacific. They have also been sighted in
34 Hawaii (Herman et al. 1980), California (Scarff 1986), Washington and British Columbia. Their migration
35 patterns are unknown, but are believed to include north-south movements between summer and winter
36 feeding areas.

37
38 The scarcity of right whales is the result of an 800-year history of whaling that continued into the 1960s
39 (Klumov 1962). Of all of the large whales, right whales are believed to have the highest risk of extinction
40 in the foreseeable future. Recent data suggest an estimated population of 300 in the North Atlantic and a
41 small, unknown number of individuals in the North Pacific. The southern right whale, in contrast, has shown
42 signs of a slow recovery over the past 20 years.

44 4.5.2 Life history information

45
46 In both northern and southern hemispheres, right whales have been observed in the lower latitudes and more
47 coastal waters during winter, and then tend to migrate to higher latitudes during the summer. Calving may
48 occur in winter months when their distribution is more coastal, but the lack of sighting information suggests
49 that calving may occur farther offshore. In summer and fall in both hemispheres, the distribution of right

1 whales appears linked to the distribution of their principal zooplankton prey (Winn et al.1986). Essentially
2 no information is available on the calving grounds or feeding habits of right whales in the North Pacific. The
3 western North Atlantic stock of right whales generally occurs in Northwest Atlantic waters west of the Gulf
4 Stream and are most commonly associated with cooler waters ($\leq 21^{\circ}\text{C}$). They are not found in the Caribbean
5 and have been recorded only rarely in the Gulf of Mexico.

6
7 Right whales in the North Pacific are known to prey on a variety of zooplankton species including *Calanus*
8 *plumchrus*, *C. cristatus*, *Euphausia pacifica*, *Metridia* spp., and copepods of the genus *Neocalanus*.. This
9 is similar to the feeding habits of right whales in the Gulf of Maine, which feed on zooplankton (primarily
10 copepods) (see NMFS 1991b, Murison and Gaskin 1989). Right whales may compete with sympatric sei
11 whales and many other predators or consumers of zooplankton in the eastern North Pacific and Bering Sea.
12 Killer whales are suspected as possible predators, but no data from the North Pacific support this speculation
13 (Scarff 1986).

14 15 **4.5.3 Listing status**

16
17 Since 1949, the northern right whale has been protected from commercial whaling by the IWC. Right
18 whales (both *E. glacialis* and *E. australis*) are listed as endangered under the ESA. They are also
19 protected by the Convention on International Trade in Endangered Species of wild flora and fauna and
20 the Marine Mammal Protection Act of 1972. NMFS designated critical habitat for the North Atlantic
21 population of right whales on June 3, 1994 (59 FR 28793). Critical habitat has not been designated for
22 right whales in the North Pacific Ocean.

23 24 **4.5.4 Population status and trends**

25
26 The population dynamics of right whales are unknown. The recovery plan for this species suggests that
27 its pre-exploitation abundance was higher than 11,000, based on a known harvest of over 11,000 by U.S.
28 whalers with additional numbers struck and lost (Brownell et al. 1986). Current population estimates
29 range from a low of 100–200 (Braham and Rice 1984) to a high of 220–500 (Berzin and Yablokov 1978
30 [in Berzin and Vladimirov 1981]), but Hill and DeMaster (1998) argue that it is not possible to
31 produce a reliable estimate of population size or trends for the right whale in the North Pacific. No
32 population projections are available.

33
34 Several researchers have suggested that the recovery of right whales in the northern hemisphere has been
35 slowed by other whales that compete with right whales for food (Rice 1974, Scarff 1986). Mitchell
36 (1975) analyzed trophic interactions among baleen whales in the western north Atlantic and noted that
37 the foraging grounds of right whales overlapped with the foraging grounds of sei whales and both
38 preferentially feed on copepods. Reeves et al. (1978) noted that several species of whales feed on
39 copepods in the eastern north Pacific, so that the foraging pattern and success of right whales would be
40 affected by other whales as well. Mitchell (1975) argued that the right whale population in the north
41 Atlantic had been depleted by several centuries of whaling before steam-driven boats allowed whalers to
42 hunt sei whales; from this, he hypothesized that the decline of the right whale population made more food
43 available to sei whales and helped their population to grow. He then suggested that the larger sei whale
44 population competes with the smaller right whale population and slows or prevents its recovery.

45 46 **4.5.5 Impacts of human activity on the species**

47
48 Before whaling began in the North Pacific Ocean, right whales were considered common or abundant in
49 the North Pacific (Webb 1988). By 1900, observations of right whales in the North Pacific had become

1 so rare, it was impossible to know their population status or trend. In the Atlantic Ocean, the major
2 known sources of anthropogenic mortality and injury of right whales include entanglement in commercial
3 fishing gear and ship strikes. Scarff (1986) concluded that entanglement in fishing gear, noise, or
4 continued hunting by countries who are not members of the IWC were not serious threats to right whales
5 in the North Pacific. However, Scarff (1986) concluded that right whales in the North Pacific are
6 particularly vulnerable to ship strikes and marine pollution because of their habit of feeding at, or near,
7 the water surface.

8
9 Undersea exploration and development of mineral deposits, and the dredging of major shipping channels
10 are continued threats to the coastal habitat of the right whale in both the North Atlantic and North
11 Pacific. Offshore oil and gas activities have been proposed off the coast of the mid- and south- Atlantic
12 U.S. and are currently being conducted in the Bering Sea and in eastern North Pacific. In Russian waters,
13 two fishery-related mortalities have been reported and offshore oil and gas development could potentially
14 affect northern right whale habitat (Perry et al. 1999).

15 16 **4.6 Sei Whale**

17 18 **4.6.1 Species description and distribution**

19
20 Sei whales are distributed in all of the world's oceans, except the Arctic Ocean. The IWC's Scientific
21 Committee groups all of the sei whales in the entire North Pacific Ocean into one stock (Donovan 1991).
22 However, some mark-recapture, catch distribution, and morphological research indicated that more than
23 one stock exists; one between 175°W and 155°W longitude, and another east of 155° W longitude
24 (Masaki 1976, 1977). During the winter, sei whales are found from 20°–23° N and during the summer
25 from 35°–50° N (Masaki 1976, 1977). Horwood (1987) reported that 75–85% of the total North Pacific
26 population of sei whales resides east of 180° longitude.

27
28 In the North Pacific Ocean, sei whales have been reported primarily south of the Aleutian Islands, in
29 Shelikof Strait and waters surrounding Kodiak Island, in the GOA, and inside waters of southeast Alaska
30 (Nasu 1974, Leatherwood et al. 1982). Sei whales have been occasionally reported from the Bering Sea
31 and in low numbers on the central Bering Sea shelf (Hill and DeMaster 1998). Masaki (1977) reported
32 sei whales concentrating in the northern and western Bering Sea from July through September, although
33 other researchers question these observations because no other surveys have ever reported sei whales in
34 the northern and western Bering Sea. Horwood (1987) evaluated the Japanese sighting data and
35 concluded that sei whales rarely occur in the Bering Sea.

36 37 **4.6.2 Life history information**

38
39 Reproductive activities for sei whales occur primarily in winter. Gestation is about 12.7 months and the
40 calving interval is about 3 years (Rice 1977). Sei whales become sexually mature at about age 10 (Rice
41 1977). The age structure of the sei whale population is unknown. Rice (1977) estimated total annual
42 mortality for adult females as 0.088 and adult males as 0.103. Andrews (1916) suggested that killer
43 whales attacked sei whales less frequently than fin and blue whales in the same areas.

44
45 Sei whales in the North Pacific feed on euphausiids and copepods, which make up about 95% of their
46 diets (Calkins 1986). The balance of their diet consists of squid and schooling fish, including smelt, sand
47 lance, Arctic cod, rockfish, pollock, capelin, and Atka mackerel (Nemoto and Kawamura 1977). Rice
48 (1977) suggested that the diverse diet of sei whales may allow them greater opportunity to take advantage
49 of variable prey resources, but may also increase their potential for competition with commercial

1 fisheries.

2
3 Endoparasitic helminths are commonly found in sei whales and can result in pathogenic effects when
4 infestations occur in the liver and kidneys (Rice 1977).

5 6 **4.6.3 Listing status**

7
8 In the North Pacific, the IWC began management of commercial taking of sei whales in 1970, and fin
9 whales were given full protection in 1976 (Allen 1980). Sei whales were listed as endangered under the
10 ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species
11 of wild flora and fauna and the Marine Mammal Protection Act of 1972. They are listed as endangered
12 under the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has
13 not been designated for sei whales.

14 15 **4.6.4 Population status and trends**

16
17 Sei whale abundance prior to commercial whaling in the North Pacific has been estimated at 42,000 sei
18 whales (Tillman 1977). Japanese and Soviet catches of sei whales in the North Pacific and Bering Sea
19 increased from 260 whales in 1962 to over 4,500 in 1968 and 1969, after which the sei whale population
20 declined rapidly (Mizroch et al. 1984). When commercial whaling for sei whales ended in 1974, the
21 population of sei whales in the North Pacific had been reduced to between 7,260 and 12,620 animals
22 (Tillman 1977).

23
24 Current abundance or trends are not known for stocks in the North Pacific. In California waters, only
25 one confirmed and five possible sei whale sightings were recorded during 1991, 1992, and 1993 aerial
26 and ship surveys (Carretta and Forney 1993, Mangels and Gerrodette 1994). No sightings were
27 confirmed off Washington and Oregon during recent aerial surveys.

28
29 Several researchers have suggested that the recovery of right whales in the northern hemisphere has been
30 slowed by other whales that compete with right whales for food. Mitchell (1975) analyzed trophic
31 interactions among baleen whales in the western north Atlantic and noted that the foraging grounds of
32 right whales overlapped with the foraging grounds of sei whales and both preferentially feed on
33 copepods. Mitchell (1975) argued that the right whale population in the north Atlantic had been depleted
34 by several centuries of whaling before steam-driven boats allowed whalers to hunt sei whales; from this,
35 he hypothesized that the decline of the right whale population made more food available to sei whales
36 and helped their population to grow. He then suggested that the larger sei whale population competes
37 with the smaller right whale population and slows or prevents its recovery.

38
39 The patterns in the eastern north Pacific Ocean: right whales and sei whales have overlapping foraging
40 areas; right whales feed almost entirely on copepods, which sei whales prefer; and whalers depleted the
41 population of right whales almost a century before they began to hunt sei whales (Rice 1974, Scarff
42 1986). Reeves et al. (1978) noted that several species feed of copepods in the eastern north Pacific, so the
43 foraging pattern of sei whales may affect the foraging success of right whales.

44 45 **4.6.5 Impacts of human activity on the species**

46
47 From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean
48 (Horwood 1987, Perry et al. 1999). From the early 1900s, Japanese whaling operations consisted of a
49 large proportion of sei whales: 300–600 sei whales were killed per year from 1911 to 1955. The sei

1 whale catch peaked in 1959, when 1,340 sei whales were killed. In 1971, after a decade of high sei
2 whale catch numbers, sei whales were scarce in Japanese waters. In the eastern north Pacific, the sei
3 whale population appeared to number about 40,000 animal until whaling began in 1963; by 1974, the sei
4 whale population had been reduced to about 8,000 animals (Tilman 1977).

5
6 No recent reports indicate sei whales are being killed or seriously injured as a result of fishing activities
7 in any eastern North Pacific fishery (Perry et al. 1999). However, Barlow et al. (1997) note that a
8 conflict may exist in the offshore drift gillnet fishery.

9 10 **4.7 Sperm Whale**

11 12 **4.7.1 Species description and distribution**

13
14 Sperm whales are distributed in all of the world's oceans. Several authors have recommended three or
15 more stocks of sperm whales in the North Pacific for management purposes (Kasuya 1991, Bannister and
16 Mitchell 1980). However, the IWC's Scientific Committee designated two sperm whale stocks in the
17 North Pacific: a western and eastern stock (Donovan 1991). The line separating these stocks has been
18 debated since their acceptance by the IWC's Scientific Committee. For stock assessment purposes,
19 NMFS recognizes three discrete population "centers" of sperm whales: (1) Alaska, (2)
20 California/Oregon/Washington, and (3) Hawaii.

21
22 Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and
23 temperate waters to the Bering Sea as far north as Cape Navarin. Mature female and immature sperm
24 whales of both sexes are found in more temperate and tropical waters from the equator to around 45°N
25 throughout the year. These groups of adult females and immature sperm whales are rarely found at
26 latitudes higher than 50°N and 50°S (Reeves and Whitehead 1997). Sexually mature males join these
27 groups throughout the winter. During the summer, mature male sperm whales are thought to move north
28 into the Aleutian Islands, GOA, and the Bering Sea.

29
30 Sperm whales are rarely found in waters less than 300 m in depth. They are often concentrated around
31 oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters.
32 Because they inhabit deeper pelagic waters, their distribution does not include the broad continental shelf
33 of the Eastern Bering Sea and these whales generally remain offshore in the eastern AI, GOA, and the
34 Bering Sea.

35 36 **4.7.2 Life history information**

37
38 Female sperm whales take about 9 years to become sexually mature (Kasuya 1991, as cited in Perry et al.
39 1999). Male sperm whales take between 9 and 20 years to become sexually mature, but will require
40 another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991).
41 Adult females give birth after about 15 months gestation and nurse their calves for 2 –3 years. The
42 calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the
43 sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978).
44 Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of
45 mortality rate for juveniles and adults are now considered unreliable (IWC 1980, as cited in Perry et al.
46 1999).

47
48 Sperm whales are known for their deep foraging dives (in excess of 3 km). They feed primarily on
49 mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich

1 1968, Berzin 1971). Perez (1990) estimated that their diet in the Bering Sea was 82% cephalopods
2 (mostly squid) and 18% fish. Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish,
3 Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey,
4 skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986b). Sperm whales taken in the GOA in the
5 1960s had fed primarily on fish. Daily food consumption rates for sperm whales ranges from 2 - 4% of
6 their total body weight (Lockyer 1976b, Kawakami 1980).

7
8 Potential sources of natural mortality in sperm whales include killer whales and papilloma virus
9 (Lambertson et al. 1987).

10 11 **4.7.3 Listing status**

12
13 Sperm whales have been protected from commercial harvest by the IWC since 1981, although the
14 Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead
15 1997). Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the
16 Convention on International Trade in Endangered Species of wild flora and fauna and the Marine
17 Mammal Protection Act of 1972. Critical habitat has not been designated for sperm whales.

18 19 **4.7.4 Population status and trends**

20
21 Current estimates for population abundance, status, and trends for the Alaska stock of sperm whales are
22 not available (Hill and DeMaster 1999). Approximately 258,000 sperm whales in the North Pacific were
23 harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). In particular, the
24 Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry et al.
25 1999). Catches in the North Pacific continued to climb until 1968, when 16,357 sperm whales were
26 harvested. Catches declined after 1968 through limits imposed by the IWC.

27 28 **4.7.5 Impacts of human activity on the species**

29
30 In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet
31 operations, which killed or seriously injured an average of 9 sperm whales per year from 1991–95
32 (Barlow et al. 1997). Interactions between longline fisheries and sperm whales in the GOA have been
33 reported over the past decade (Rice 1989, Hill and DeMaster 1999). Observers aboard Alaskan sablefish
34 and halibut longline vessels have documented sperm whales feeding on longline-caught fish in the GOA.
35 During 1997, the first entanglement of a sperm whale in Alaska's longline fishery was recorded, although
36 the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate
37 sperm whales are being killed or seriously injured as a result of these interactions, although the nature
38 and extent of interactions between sperm whales and long-line gear is not yet clear.

39
40 In 2000, the Japanese Whaling Association announced that it proposed to kill 10 sperm whales in the
41 Pacific Ocean for research purposes, which was the first time sperm whales have been taken since the
42 international ban on commercial whaling took effect in 1987. Despite protests from the U.S. government
43 and members of the IWC, the Japanese government plans to conduct this research. The implications of
44 this action for the status and trend of sperm whales is uncertain.

45 46 **4.8 Steller Sea Lion**

47 48 **4.8.1 Species description**

1 The Steller sea lion (*Eumetopias jubatus*) is the only extant species of the genus *Eumetopias*, and is a
2 member of the subfamily Otariinae, family Otariidae, superfamily Otarioidea, order Pinnipedia. The
3 closest extant relatives of the Steller sea lion appear to be the other sea lion genera, including *Zalophus*,
4 *Otaria*, *Neophoca*, and *Phocarcos*, and the fur seals of the genera *Callorhinus* and *Arctocephalus*.
5 Loughlin *et al.* (1987) provide a brief but informative summary of the fossil record for *Eumetopias*.
6 Repenning (1976) suggests that a femur dated 3 to 4 million years old may have been from an ancient
7 member of the *Eumetopias* genus, thereby indicating that the genus is at least that old. *Eumetopias*
8 *jubatus* likely evolved in the North Pacific (Repenning 1976).
9

10 **4.8.2 Distribution**

11
12 Steller sea lions are distributed around the North Pacific rim from the Channel Islands off Southern
13 California to northern Hokkaido, Japan. The species' distribution extends northward into the Bering Sea
14 and along the eastern shore of the Kamchatka Peninsula. The GOA and the Aleutian Islands are
15 considered the geographic center of the sea lions' distribution (Kenyon and Rice 1961).
16

17 Within this distribution, land sites used by Steller sea lions are referred to as rookeries and haulout sites.
18 In the Bering Sea, the northernmost major rookery is on Walrus Island (Pribilof Islands) and their
19 northernmost major haulout is on Hall Island (off the northwestern tip of St. Matthew Island). Rookeries
20 are used by adult males and females for pupping, nursing, and mating during the reproductive season
21 (late May to early July). Haulouts are used by all size and sex classes but are generally not sites of
22 reproductive activity. The continued use of particular sites may be due to site fidelity, or the tendency of
23 sea lions to return repeatedly to the same site, often the site of their birth. Presumably, these sites were
24 chosen and continue to be used because of their substrate and terrain, the protection they offer from
25 terrestrial and marine predators, protection from severe climate or sea surface conditions, and the
26 availability of prey resources.
27

28 Steller sea lion movement patterns from a land base (rookery or haulout) might be categorized into at
29 least three types. First, sea lions move on and offshore for feeding excursions. Limited data are
30 available to describe these movements (e.g., Gentry 1970, Sandgren 1970, Merrick and Loughlin 1997),
31 but such descriptions are essential for understanding foraging patterns, nursing strategies, and energetics.
32 Second, at the end of the reproductive season, some females may move with their pups to other haulout
33 sites and males may disperse to distant foraging locations (Spaulding 1964, Mate 1973, Porter 1997).
34 Some data indicate that animals do shift from rookeries to haulouts, but the timing and nature of these
35 movements need further description (i.e., what distances are involved, are movements relatively
36 predictable for individuals, do movements vary with foraging conditions, etc.). Description of these
37 types of movements are essential for understanding seasonal distribution changes, foraging ecology, and
38 apparent trends as a function of season. Third, sea lions may make semi-permanent or permanent one-
39 way movements from one site to another (Chumbley *et al.* 1997, their Table 8; Burkanov *et al.* unpubl.
40 report [cited in Loughlin 1997]). Calkins and Pitcher (1982) reported movements of up to 1500 km.
41 They also describe wide dispersion of young animals after weaning, with the majority of those animals
42 returning to the site of birth as they reach reproductive age.
43

44 The distribution of Steller sea lions at sea is not well understood. Their at-sea distribution is, however, a
45 critical element to any understanding of potential effects of fisheries on Steller sea lions, and will be
46 considered in greater detail below in the section on foraging patterns (see section 4.8.6).
47

48 **4.8.3 Reproduction**

1 Steller sea lions have a polygynous reproductive system where a single male may mate with multiple
2 females. As mating occurs on land (or in the surf or intertidal zones), males are able to defend territories
3 and thereby exert at least partial control over access to adult females and mating privileges. The pupping
4 and mating season is relatively short and synchronous, probably due to the strong seasonality of the sea
5 lions' environment and the need to balance aggregation for reproductive purposes with dispersion to take
6 advantage of distant food resources (Bartholomew 1970). In May, adult males compete for rookery
7 territories. In late May and early June, adult females arrive at the rookeries, where pregnant females give
8 birth to a single pup. The sex ratio of pups at birth is approximately 1:1 or biased toward slightly greater
9 production of males (e.g., Pike and Maxwell 1958, Lowry et al. 1982, NMFS 1992).

10
11 Mating occurs about one to two weeks later (Gentry 1970). The gestation period is probably about 50 to
12 51 weeks, but implantation of the blastocyst is delayed until late September or early October (Pitcher and
13 Calkins 1981). Due to delayed implantation, the metabolic demands of a developing fetus are not
14 imposed on the female until well into fall and early winter.

15
16 After parturition (birth), females nurse their pups over a period of months to several years. Merrick et al.
17 (1995) compared pup sizes at different sites where Steller sea lion populations were either decreasing or
18 increasing, to determine if pup size or growth may be compromised in decreasing populations. Their
19 results were not consistent with that hypothesis; rather, they found that pups about two to four weeks of
20 age were larger at sites in the Aleutian Islands and GOA than they were in southeast Alaska or Oregon.
21 These observed differences indicate that at least this phase of reproduction may not be affected; that is, if
22 females are able to complete their pregnancy and give birth, then the size of those pups does not appear
23 to be compromised. Possible alternative explanations for the observed size differences are that pups
24 were measured at different ages (i.e., pups in the GOA and Aleutian Islands may have been born earlier
25 and therefore were older when weighed), or that over time, harsher environmental conditions in the
26 Aleutian Islands of the GOA have selected for larger pup size.

27
28 The length of the nursing period may be an important indicator of the female's condition and ability to
29 support her pup, and the pup's condition at weaning (and hence, the likelihood that the pup will survive
30 the post weaning period). Thorsteinson and Lensink (1962) suggested that nursing of yearlings was
31 common at Marmot Island in 1959. Pitcher and Calkins (1981) suggested that it is more common for
32 pups to be weaned before the end of their first year, but they also observed nursing juveniles (aged 1 to
33 3). Porter (1997) distinguished metabolic weaning (i.e., the end of nutritional dependence of the pup or
34 juvenile on the mother) from behavioral weaning (i.e., the point at which the pup or juvenile no longer
35 maintains a behavioral attachment to the mother). He also suggested that metabolic weaning is more
36 likely a gradual process occurring over time and more likely to occur in March–April, preceding the next
37 reproductive season. The transition to nutritional independence may, therefore, occur over a period of
38 months as the pup begins to develop essential foraging skills, and depends less and less on the adult
39 female. The length of the nursing period may also vary as a function of the condition of the adult female.
40 The nature and timing of weaning is important because it determines the resources available to the pup
41 during the more demanding winter season and, conversely, the demands placed on the mother during the
42 same period. The maintenance of the mother-offspring bond may also limit their distribution or the area
43 used for foraging.

44
45 Relatively little is known about the life history of sea lions during the juvenile years between weaning
46 and maturity. Pitcher and Calkins (1981) reported that females sampled in the late 1970s reached
47 reproductive maturity between ages 2 and 8, and the average age of first pregnancy was 4.9 ± 1.2 years.
48 These results suggest a mean age of first birth of about 6 years. The available literature indicates an
49 overall reproductive (birth) rate on the order of 55% to 70% or greater (Pike and Maxwell 1958, Gentry

1 1970, Pitcher and Calkins 1981, Pitcher *et al.* in review). York (1994) derived the age-specific fecundity
2 rates in Table 4.1 based on data from Calkins and Pitcher (1982). Those rates illustrate a number of
3 important points and assumptions. First, the probability of pupping is rare (about 10%) for animals 4
4 years of age or younger. Second, maturation of 100% of a cohort of females occurs over a prolonged
5 period which may be as long as 4 years. Third, the reported constancy of fecundity extending from age 6
6 to 30 indicates that either senescence has no effect on fecundity, or our information on fecundity rates is
7 not sufficiently detailed to allow confident estimation of age-specific rates for animals older than age 6.
8 Given the small size of the sample taken, the latter is a more likely explanation for such constancy.
9

10 For mature females, the reproductive cycle includes mating, gestation, parturition, and nursing or post-
11 natal care. The reproductive success of an adult female is determined by a number of factors within a
12 cycle and over time through multiple cycles (Fig. 4.1). The adult female's ability to complete this cycle
13 successfully is largely dependent on the resources available to her. While much of the effort to explain
14 the Steller sea lion decline has focused on juvenile survival rates, considerable evidence suggests that
15 decreased reproductive success may also have contributed to the decline.
16

- 17 • Young females collected in the 1970s were larger than females of the same age
18 collected in the 1980s (Calkins *et al.* 1998). As size, as well as age, may
19 influence the onset of maturity, females in the 1980s would also be more likely
20 to mature and begin to contribute to population productivity at a later age.
21
- 22 • Pitcher *et al.* (1998) provide data from the 1970s and 1980s that suggests a high
23 pregnancy rate after the mating season (97%; both periods), which declined to
24 67% for females collected in the 1970s and 55% for females collected in the
25 1980s. These changes in pregnancy rate suggest a high rate of fetal mortality
26 that could be a common feature of the Steller sea lion reproductive strategy (i.e.,
27 may occur even when conditions are favorable and population growth is
28 occurring), but is more likely an indication of stress (possibly nutritional)
29 experienced by individual females.
30
- 31 • The observed differences in late pregnancy rates (67% in the 1970s and 55% in
32 the 1980s) were not statistically significant. However, the direction of the
33 difference is consistent with the hypothesis that reproductive effort in the 1980s
34 was compromised.
35
- 36 • Pitcher *et al.* (1998) did observe a statistical difference in the late season
37 pregnancy rates of lactating females in the 1970s (63%) versus lactating females
38 in the 1980s (30%). This difference indicates that in contrast to lactating
39 females in the 1970s, lactating females in the 1980s were less able to support a
40 fetus and successfully complete consecutive pregnancies.
41

42 Males reach sexual maturity at about the same time as females (i.e., 3-7 years of age, reported in
43 Loughlin *et al.* 1987), but generally do not reach physical maturity and participate in breeding until about
44 8 to 10 years of age (Pitcher and Calkins 1981). A sample of 185 territorial males from Marmot, Atkins,
45 Ugamak, Jude, and Chowiet Islands in 1959 included animals 6 to 17 years of age, with 90% from 9 to
46 13 years old (Thorsteinson and Lensink 1962).
47
48

4.8.4 Survival

Much of the recent effort to understand the decline of Steller sea lions has been focused on juvenile survival, or has assumed that the most likely proximate explanation is a decrease in juvenile survival rates. This contention is consistent with direct observations and a modeling study, and is consistent with the notion that juvenile animals are less adept at avoiding predators and obtaining sufficient resources (prey) for growth and survival.

The direct observations consist of extremely low resighting rates at Marmot Island of 800 pups tagged and branded at that site in 1987 and 1988 (Chumbley et al. 1997) and observations of relatively few juveniles at Ugamak (Merrick et al. 1988). The low resighting rates do not themselves confirm that the problem was a corresponding drop in juvenile survival, but only that many of the marked animals were lost to the Marmot Island population. Migration to other sites where they were not observed is a possibility, but unlikely given the observations of relatively high site fidelity of animals returning to breed at their natal site. If the “loss” of these animals is viewed in the context of the overall sea lion decline in the central GOA (from 1976 to 1994 the number of non-pups counted at Marmot Island declined by 88.9% and by 76.9% at the 14 other trend sites in the Gulf; Chumbley et al. 1997), then a significant increase in juvenile mortality is a much more plausible conclusion.

Modeling by York (1994) provides evidence that the observed decline in sea lion abundance in the GOA may have been due to an increase in juvenile mortality. York used the estimated rate of decline between the 1970s and the 1980s, and the observed shift in the mean age of adult females (≥ 3 years of age) to explore the effects of changes in adult reproduction, adult survival, and juvenile survival. While she pointed out that the observed decline did not rule out all other possible explanations, she concluded that the observed decline is most consistent with a decrease in juvenile survival on the order of 10 to 20% annually.

However, juvenile survival is not assumed to be the only factor influencing the decline of the western population of Steller sea lions. Evidence indicating a decline in reproduction was presented in the previous section. In addition, changes in adult survival may also have contributed to the decline. At present, survival rates for adult animals can not be determined with sufficient resolution to determine if those rates have changed over time or are somehow compromised to the extent that population growth and recovery are compromised.

4.8.5 Age distribution

Two life tables have been published with age-specific rates (Table 4.1). The first was from Calkins and Pitcher (1982) and was based on sea lions killed in the late 1970s. York (1994) created a second life table using a Weibull model and the data from Calkins and Pitcher (1982) and Calkins and Goodwin (1988). York’s analysis of these two data sets suggests a shift from the 1970s to the 1980s in the mean age of females older than 3 years of age. The shift was about 1.55 years, and provided the basis for her determination that increased juvenile mortality may have been an important proximate factor in the decline of Steller sea lions. That is, such a shift in mean age would occur as the adult population aged without expected replacement by recruitment of young females.

The most apparent limitations of these data and the resulting life tables are 1) the collected sea lions were not from the same locations and the relations between populations at different sites have not been described (e.g., were they experiencing similar trends and were their age structures comparable), 2) the data and estimated vital rates are also time-specific, and do not necessarily apply to the current

1 population, 3) the assumption of a stable age distribution (or distributions) may be faulty even if trends at
2 these different sites were consistent, and 4) the data set is relatively small and does not provide a basis
3 for estimating age-specific survival rates for very young ages (0–2 years of age) or for possibly senescent
4 older animals (say >12 years of age). Until senescence is assessed, longevity for Steller sea lions will be
5 difficult to describe. The data reported in Pitcher and Calkins (1981) indicate that female sea lions may
6 live to 30 years of age. A Weibull function fit to these data (York 1994) indicates, however, that fewer
7 than 5% of females live to age 20.

8
9 The present age distribution may or may not be consistent with these life tables. Nevertheless, these
10 tables provide the best available information on vital parameters, and the present age structure of sea
11 lions may be similar if the immediate causes of the decline (e.g., low juvenile survival or low
12 reproductive rates) have remained relatively constant.

13 14 **4.8.6 Steller sea lion foraging behavior**

15
16 The foraging patterns of Steller sea lions are central to the discussion of the interaction between this
17 species and commercial fisheries. The two most important factors are Steller sea lion foraging locations
18 and prey selectivity. A list of published foraging studies is provided in Table 4.2, together with notes on
19 the sample sizes, locations, years, and primary findings of those studies.

20 21 **4.8.6.1 Methods for researching sea lion foraging behavior**

22
23 Current understanding of Steller sea lion foraging patterns are based on the following methods.

24 25 **Observations**

26
27 Foraging patterns can be discerned, in part, simply by observational studies.
28 Observations can be useful for identifying areas that may be important foraging sites
29 (e.g., Kajimura and Loughlin 1988, Fiscus and Baines 1966). The designation of critical
30 habitat was based, in part, on observations that sea lions use those areas extensively for
31 foraging. Similarly, under certain circumstances observations can be used for identifying
32 prey items, particularly those that may be commercially important (e.g., Jameson and
33 Kenyon 1977). In general, however, the power of observational studies is limited to
34 situations where sea lions bring their prey to the surface and the prey can be identified,
35 or where the sea lions can be observed diving repeatedly and the assumption that they are
36 foraging is reasonable.

37 38 **Stomach and intestinal contents**

39
40 Stomach contents are generally considered to be the most reliable indication of foraging
41 patterns. Nonetheless, biases may occur from a number of sources. Variable rates of
42 digestion of soft tissues or variable retention of hard tissues (e.g., squid beaks) may
43 result in misrepresentation of prey detection in the stomach. For example, Pitcher (1981)
44 indicated that results from intestinal tracts may not correspond to results from stomachs.
45 Stomach contents generally indicate prey items recently consumed, and may or may not
46 be representative of prey items over a longer period of time. Results also may be biased
47 by the evaluation method (e.g., use of frequency of occurrence may indicate how many
48 animals ingested a prey type, but may not provide a good indicator of the importance of
49 that prey; see Spalding 1964). Analyses of stomach contents have provided a large

1 portion of our information on sea lion foraging (e.g., Calkins and Pitcher 1982, Calkins
2 and Goodwin 1988), but under most conditions, killing for collection of stomach
3 contents is no longer considered appropriate. Stomach and intestinal contents are now
4 available only from dead animals found on beaches or live animals that are under
5 sedation and can be lavaged or given an enema.

6 7 **Scat analysis**

8
9 Scats, or feces, are being used to study Steller sea lion prey selection, and have provided
10 important information on the frequency of occurrence of various prey species in the sea
11 lion diet (e.g., Merrick et al. 1997). Materials from scats, such as otoliths, can be used
12 with additional information (e.g., size at age) to make inferences about the prey
13 consumed (Pitcher 1981, Frost and Lowry 1986). As with stomach and intestinal
14 contents, scats are known to be a biased index of prey selection because some prey may
15 not have hard parts that resist digestion and can be identified in a scat, and the scat
16 generally contains prey items consumed relatively recently (depending on the rate of
17 passage through the digestive tract). Nevertheless, scat collections provide a non-lethal
18 means of assessing diet and diet changes over time and space, and estimating relative
19 frequency of occurrence of prey items in the sea lion diet. Since about 1990, NMFS has
20 used scats as the primary tool for determining diet preferences for Steller sea lions in
21 Alaska.

22 23 **Telemetry**

24
25 At least three types of telemetry are (or have been) used to study sea lion foraging. Very
26 high frequency (VHF) telemetry can be used to determine presence or absence of an
27 animal and, to some extent, animal location and whether it is on land or in the water.
28 The use of VHF telemetry to determine the presence or absence of an animal can be used
29 to infer the occurrence and length of foraging trips (e.g., Merrick and Loughlin 1997),
30 and movement patterns between sites that can be monitored manually, remotely, or
31 automatically by VHF receivers.

32
33 Satellite-linked telemetry is being used to determine animal location and diving patterns
34 when coupled with time-depth recorders (e.g., Merrick et al. 1994). Satellite-linked
35 telemetry provides an opportunity to gather information on animal location without
36 having to recapture the animal to collect stored data. At present, satellite-linked
37 telemetry is the most cost-effective means of assessing the distribution of foraging
38 animals and thereby determining those regions that are critical for Steller sea lions.

39
40 Telemetry devices that record stomach temperature are being developed and offers an
41 opportunity to determine when an animal has consumed prey, rather than requiring the
42 investigator to infer feeding from diving behavior. This type of telemetry, in
43 combination with satellite-linked telemetry, may provide greater understanding of
44 foraging behavior and discrimination of at-sea activities that may or may not be related
45 to foraging.

46 47 **Physiology and captive studies**

48
49 Studies of animals in captivity may be useful for understanding prey selection, diving

1 and foraging physiology, and energetics. Various studies have examined assimilation
2 efficiency, changes in weight as a function of prey type (Fadely et al. 1994, Rosen and
3 Trites 1999, Rosen and Trites 2000), metabolic rates, the heat increment of feeding
4 (Rosen and Trites 1998, 2000), and the metabolic effect of fasting (Rea et al. 2000).
5 Energetic and nutritional studies on captive animals will likely form a basis from which
6 dietary requirements of wild animals can be determined and understood. The issue of
7 competition between groundfish fisheries and the Steller sea lion may be decided on the
8 basis of demographic, ecological, or other information, but our understanding of such
9 competition will ultimately depend on our ability to explain their energetic and
10 nutritional needs and physiology.

11 **Fatty acid analysis**

12
13
14 Fish species vary in fatty acid composition and therefore carry their own “fatty acid
15 signature.” This signature is retained through ingestion and digestion of prey, and
16 deposition of resulting fatty acids. Therefore, removal of small tissue (blubber) plugs
17 from Steller sea lions and analysis for fatty acid composition can be used to identify prey
18 types. This method of prey analysis is relatively new (e.g., Iverson 1993), but has been
19 used successfully to identify prey types of harbor seals in different regions of Prince
20 William Sound (Iverson et al. 1997). The NMFS laboratory at Auke Bay has developed
21 the capability to conduct such analyses; this approach to prey determination will likely
22 prove useful for providing a longer-term view of sea lion diets.

23 **Isotope analysis**

24
25
26 Isotope ratios for various elements differ in prey types in a manner that allows estimation
27 of general prey category and trophic level. These analyses can be conducted using small
28 amounts of tissue (e.g., vibrissae or whiskers) and may provide evidence of long term
29 changes in general prey type, trophic level, or feeding strategy. For example, Hobson et
30 al. (1997) examined carbon and nitrogen ratios in the hair and muscle of Steller sea lions
31 and northern fur seals and were able to infer consumption of prey from different trophic
32 levels for the two species. The results also indicated variation in prey by latitude.

33 **4.8.6.2 Foraging distributions**

34
35
36 At present, our understanding of Steller sea lion foraging distribution is based on sightings at sea
37 or observations of foraging behavior (or presumed foraging behavior) in areas such as the
38 southeastern Bering Sea (Fiscus and Baines 1966, Kajimura and Loughlin 1988), records of
39 incidental take in fisheries (Perez and Loughlin 1991), and satellite-linked telemetry studies (e.g.
40 Merrick et al. 1994, Merrick and Loughlin 1997).

41 **Observations**

42
43
44 The POP database provides our best overall view of the foraging range or distribution of
45 Steller sea lions in the BSAI and the western/central GOA (Fig. 4.2a). This database and
46 the locations of sea lions taken incidentally in groundfish fisheries (1973–1988, Perez
47 and Loughlin 1991), indicate that sea lions disperse widely to forage throughout much of
48 the BSAI and the GOA, at least as far out as the continental shelf break. Such broad
49 dispersal may be essential to sea lion populations to take advantage of distant food

1 resources and, as a consequence, limit intra-specific competition near rookeries and
2 haulouts. However, this database should be viewed with some caution. The sightings in
3 this database were collected over a period of four decades and do not reflect any natural
4 changes that may have occurred in sea lion foraging patterns during that period. NMFS
5 has prepared another database with just the observations from 1991-2000 which suggests
6 similar trends (Fig. 4.2b). In the Bering Sea there have been many observations of
7 Steller sea lions along the shelf-break as far north as 60N latitude throughout the year.
8 Interestingly, the pattern of foraging (as determined from observations) seems to follow
9 the continental shelf break (i.e. the 200 m isobath) suggesting the type of foraging
10 locations preferred by some animals. However, many animals may remain within 20 nm
11 because of the proximity to a nursing pup or because of the narrowness of the continental
12 shelf (i.e. such as in the Aleutian Islands area).

13
14 The foraging range, as indicated by such sightings, would be expected to change over
15 time due to the severe decline of the species in the last two decades. In addition, the
16 database is biased as a reflection of overall foraging dispersion by the location of
17 sighting effort. That is, a sighting at a particular location indicates sea lion presence at
18 that site, but the lack of sightings at a site could mean that the site is not important for
19 foraging or it could mean that there was insufficient sighting effort in that area. Also, it
20 is not clear that each sighting represents a different animal, and it is possible that some
21 sightings were of the same animal. Finally, the sighting database does not include
22 information on the age and sex of the sighted animal. Nonetheless, the large number of
23 sightings of Steller sea lions outside of critical habitat throughout the year, particularly in
24 the eastern Bering Sea, suggests that this “outside” area is widely used by animals
25 seeking forage.

26 27 **Telemetry studies**

28
29 Telemetry studies suggest that foraging distributions vary by individual, size or age,
30 season, site, and reproductive status (Merrick and Loughlin 1997; NMFS unpublished
31 data). NMFS has deployed 80 satellite-linked recorders since June 1990 from Puget
32 Sound to the Kuril Islands. Unfortunately reliable data were available from only 53 of
33 the 80 units. Some failed completely or provided questionable data, others fell off the
34 animal prematurely. A summary of the number of deployments, sex and age, location
35 and history of the deployments is summarized in Table 4.3. NMML has analyzed and
36 published results for many of the early studies (e.g., Merrick and Loughlin 1997). Those
37 reports have served as the basis for much of our understanding of Steller sea lion
38 foraging ecology.

39
40 The range of deployment for the 80 SLTDRs ranges from 1 to 121 days with a mean of
41 37 days. Many of the early deployments failed because the epoxy got too hot and
42 chemically burned the attachment fur; it took some experimentation to develop the
43 correct mixture and brand of attachment epoxy. Recent deployments use a cooler-setting
44 epoxy and the units are about 1/4 the size of the first units so deployments tend to last
45 longer. However, Steller sea lion fur is quite brittle, when compared to other pinnipeds
46 (e.g. northern fur seals) and deployments are much briefer. It is not uncommon for an
47 instrument to stay on a fur seal for 3-8 months, where 3 months on a sea lion is
48 considered a success. Experimentation with alternate epoxies and attachment methods
49 continues.

1 The early deployments emphasized adult females with pups during the breeding season
2 simply because at the time those animals were most accessible and their status and
3 foraging ecology were of prime interest. Since then, the scientific community has
4 recognized the need to focus on young animals because they are likely the ones suffering
5 most from increased mortality rates. Thus, emphasis presently is on animals less than 4
6 years old during fall through early spring for both NMFS and ADFG deployments.
7

8 *Merrick and Loughlin (1997)*
9

10 The foraging patterns of adult females, as described by Merrick and Loughlin (1997),
11 differed during summer months when females were with pups versus winter periods
12 when considerable individual variation was observed, but may be attributable to the
13 lactation condition of the females. Trip duration for females ($n = 14$) in summer was
14 approximately 18 to 25 hours. For five of those females that could be tracked, trip length
15 averaged 17 km and they dove approximately 4.7 hours per day. For five females
16 tracked in winter months, mean trip duration was 204 hours, mean trip length was 133
17 km, and they dove 5.3 hours per day. The patterns exhibited by females in winter varied
18 considerably, from which the investigators inferred that two of them may still have been
19 supporting a pup. Those two females continued to make relatively shorter trips (mean of
20 53 km over 18 hours) and dove 8.1 hours per day, whereas the other three ranged further,
21 dove 3.5 hours per day, and spent up to 24 days at sea. Five winter young-of-the-year
22 exhibited foraging patterns intermediate between summer and winter females in trip
23 distance (mean of 30 km), but shorter in duration (mean of 15 hours), and with less effort
24 devoted to diving (mean of 1.9 hours per day). Estimated home ranges (mean \pm 1 SE)
25 were 319 ± 61.9 km² for adult females in summer, $47,579 \pm 26,704$ km² for adult females
26 in winter, and $9,196 \pm 6799$ km² for winter young-of-the-year. The sea lions used in
27 Merrick and Loughlin's (1997) study were from the GOA (Sugarloaf Island, Latax
28 Rocks, Marmot Island, Long Island, Chirikof Island, Atkins Island, and Pinnacle Rock),
29 and the BSAI region (Ugamak Island and Akun Island). This information is, therefore,
30 directly pertinent to the action areas for both the GOA and BSAI fisheries, although it is
31 perhaps most relevant to the GOA action area.
32

33 In general, there is substantial individual variation in distance traveled by Steller sea
34 lions. For adult females, the information currently available suggests that they remain
35 within 20 nm during the breeding season, as well as other seasons if they are nursing a
36 pup. Once the breeding season ends (late July/early August) this general pattern may
37 change. However, we have extremely limited telemetry data from the fall (October to
38 December) to support any hypothesis for that season. Since most of the animals
39 instrumented have been either females or pups, the data may not accurately represent the
40 male portion of the population, which are believed to be much more likely to disperse
41 over larger areas. This hypothesis is based on the POP database and limited telemetry
42 data available.
43

44 **Critical habitat** 45

46 Based on the foraging distribution of Steller sea lions, NMFS designated critical habitat
47 for the species on August 27, 1993 (58 FR 45269) . NMFS used both observations and
48 incidental take of Steller sea lions to determine the appropriate area to list as critical
49 habitat under the ESA (Loughlin and Nelson 1986, Perez and Loughlin 1991). The

1 critical habitat boundary was not intended to include the entire geographic area used by
2 foraging Steller sea lions. As required by the ESA, critical habitat must include only
3 those areas necessary for the conservation of the species. When designating critical
4 habitat in 1993, NMFS acknowledged that “other aquatic habitats within their range are
5 essential to Steller sea lions for foraging.” Three relatively large foraging areas were
6 also listed as critical habitat in addition to the 20 nm boundaries around listed rookeries
7 and haulouts (i.e., Seguam Pass, the Bogoslof Foraging Area in the southeastern Bering
8 Sea, and Shelikof Strait Foraging Area).

9
10 Additionally, after the jeopardy Biological Opinion in 1998, for the BSAI and GOA
11 pollock fisheries, NMFS took steps under the RFRPAs to protect foraging areas not
12 previously listed as critical habitat (i.e., other non-listed haulouts). Presently, NMFS
13 requires protection of core habitat areas in order to conserve listed species, but also
14 allows for protection, generally at lesser degrees, outside of critical habitat. The goal of
15 the ESA is to promote the recovery of listed species; therefore, such protections as
16 implemented under the RFRPAs are consistent with the Act. Given the hypothesis that
17 the population of Steller sea lions relies less upon areas outside of critical habitat for
18 foraging, NMFS is likely to continue with less stringent protection measures outside of
19 critical habitat. This does not mean that these areas outside of critical habitat are
20 unimportant to Steller sea lions.

21
22 Overall, the available data suggest two types of foraging patterns: 1) foraging around
23 rookeries and haulouts that is crucial for adult females with pups, pups, and juveniles,
24 and 2) foraging that may occur over much larger areas where these and other animals
25 may range to find the optimal foraging conditions once they are no longer tied to
26 rookeries and haulouts for reproductive or survival purposes.

27 28 **4.8.6.3 Foraging depths**

29
30 In the discussion above in section 4.8.6.2 (Telemetry studies), we described the available data for
31 location of Steller sea lions based on telemetry studies. Additional to the location information,
32 the instruments also recorded time and depth. Over the years the transmitters have changed in
33 size, data storage capabilities, and transmission power resulting in differences in the type and
34 quality of data received. However, all provide information on dive depth and duration, the
35 animal's location and the duration of time spent at sea and on land (e.g., Merrick et al. 1994,
36 Merrick and Loughlin 1997, Loughlin et al 1998). A full description of the earlier units and
37 their capabilities is in Merrick et al. (1994). The polar-orbiting satellite tracking system (Argos)
38 is described in detail in Stewart et al. (1989). The SLTDRs record all dives and then summarize
39 the data into a histogram plot prior to transmission. Time-depth recorders that require recapture
40 of the animal and removal of the instrument were not an option because researchers were unable
41 to revisit the rookery sites for recapture. The instruments were not recovered and were expected
42 to be shed at or before the fall molt.

43
44 The SLTDR stored, summarized, and transmitted dive data as histograms. Software
45 programming of the SLTDR required that each day be subdivided into four 6-h periods (2100-
46 0300 hrs, 0300-0900 hrs, 0900-1500 hrs, 1500-2100 hrs local time). Histograms were separately
47 summarized for dive depth and duration for each of the four time periods. The SLTDRs were
48 programmed to record dive information into six separate bins (eight in the more recent versions).
49 The dive-depth bins were 4-10 m, 10-20 m, 20-50 m, 50-100 m, 100-250 m, and >250 m.

1 NMML uses 4 m as the minimum depth for a dive based on Merrick et al. (1994). Dive-duration
2 bins were 0-60 sec, 60-120 sec, 120-240 sec, 240-480 sec, 480-960 sec, and >960 sec. Locations
3 were estimated based on the Service-Argos classification scheme where class 3 is accurate to 150
4 m, class 2 to 350 m, class 1 to 1 km, and class 0, A, and B have no accuracy assigned. All
5 location data are used to estimate location but estimated trip distance uses all but class 0, A, and
6 B. Trip distance was estimated for individual trips as the straight-line distance from the capture
7 site to the farthest location offshore.
8

9 The information is collected and stored in the unit until the animal surfaces for a preset amount
10 of time; a salt water switch on the unit turns it off and off when submerged or on the surface.
11 Depending on the position of the Argos satellite at the time the animal surfaces, all or portions of
12 the stored information is transmitted to the satellite; the information is then sent to land-based
13 stations where it is collated and available to the user. The transmitted information contains dive
14 data as described above; locations at sea are determined from the Doppler shift of the frequencies
15 of a series of signals received by the satellite. If the satellite is directly overhead and the animal
16 surfaces for a few seconds, then two or more quality hits are obtained and good location data are
17 available along with the transmitted dive data. However, Steller sea lions often surface for only
18 short periods, or when surfacing the satellite is not overhead, resulting in no transmission or poor
19 quality location information and partial transmission of dive data. Dive data that are not
20 transmitted while at sea are stored until the animal is on land or is dumped in favor of more
21 recently collected data.
22

23 The sea lions in the Merrick and Loughlin (1997) study tended to make relatively shallow dives,
24 with few dives recorded at greater than 250 m (Fig. 4.3). Maximum depth recorded for each of
25 the five summer adult females was in the range from 100 to 250 m, and maximum depth for the
26 five winter adult females was greater than 250 m. The maximum depth measured for winter
27 young-of-the-year was 72 m. These results suggest that sea lions are generally shallow divers,
28 but are capable of deeper dives (i.e., greater than 250 m).
29

30 The instruments used to record diving depths do not determine the purpose of a dive, and many
31 of the recorded dives (Fig. 4.3) may not be indicative of foraging effort. Dives between 4 and 10
32 m depth may be for foraging, or they may be related to other behaviors such as social interactions
33 or transiting between locations. For example, animals transiting to and from foraging locations
34 during rough sea surface conditions may transit in a series of long, shallow dives to avoid such
35 conditions. The relatively large number of dives recorded between 4 and 10 m may therefore
36 bias the assessment of “foraging” depths for these sea lions.
37

38 The results from this study also may not be indicative of diving depths and patterns for other sea
39 lions at other times of year or in other locations. The winter young-of-the-year were
40 instrumented in the period from November to March, when they were about five to nine months
41 old and may have still been nursing. At this age, they are just beginning to develop foraging
42 skills. The diving depths and patterns exhibited by these young-of-the-year are not indicators of
43 the foraging patterns of older juveniles (one- to three-year-olds). For example, Swain and
44 Calkins (1997) report dives of a 2-year-old male sea lion to 252 m, and regular dives of this
45 animal and a yearling female to 150 m to 250 m (Fig. 4.4). Clearly, if young-of-the-year are
46 limited to relatively shallow depths, and older animals are capable of diving to much greater
47 depths, then those younger animals are just beginning to develop the diving and foraging skills
48 necessary to survive. The rate at which they develop those skills and begin to dive to greater
49 depths or take prey at greater depths is unknown, but probably occurs rapidly after weaning to

1 take advantage of otherwise unavailable prey resources. ADFG is currently studying the
2 ontogeny of dive behavior in young Steller sea lions.

3 4 **4.8.6.4 Prey species**

5
6 Historically, pinniped diet studies were based on the remains of prey in stomach contents.
7 Stomach contents have been collected from Steller sea lions (*Eumetopias jubatus*) killed or found
8 dead on rookeries, haulout sites and at sea from the North Pacific Coast, the Gulf of Alaska and
9 the Aleutian Islands since 1902. Early studies contained primarily narrative summaries of prey
10 occurrence but reported little quantitative information on prey occurrence (Table 4.2). As early
11 as the late 1950's, some studies used the percent frequency of occurrence as a comparative
12 measure of the incidence of prey species in the stomachs of Steller sea lions. To summarize
13 historical information on the prey of Steller sea lions, based on stomach contents, data on the
14 occurrence of prey taxa from ten studies conducted between 1956 and 1986 were pooled.
15 Comparisons of prey species consumed were made between the eastern and western range of sea
16 lions and between the 1950-90's (Table 4.2).

17 18 **Stomach analyses**

19
20 Percent frequency of occurrence was calculated from a pooled sample of 781 stomachs
21 containing prey remains (Figure 4.5, Table 4.4). Gadids increased both in the eastern and
22 western stocks from the 1950's through 1970s and the 1980s. Pollock accounted for much of the
23 increase in Gadids in both the eastern and western regions. Pacific cod and flatfish also
24 increased in both regions while cephalopods showed a slight decrease in both regions between
25 the two time periods. Other demersal fish may have decreased in the 1980s, however, this could
26 be due to a small sample size (n = 14) in the eastern region. In the western region, capelin (6.3%
27 to 0%) and sandlance (4.8% to 2.8%) decreased from the early period to the 1980s, although
28 small forage fish as a whole increased during this time period primarily due to an increase in
29 Pacific herring (4.1% to 7.9%).

30 31 **Scat analyses**

32
33 Currently, the primary method of identifying prey species consumed by pinnipeds is through
34 analysis of bony remains in scat (fecal) collections. The interpretation of predator diet through
35 the use of scat was first developed for terrestrial studies and has been adapted for use in marine
36 mammal trophic studies over the past two decades. All methods of diet evaluation in marine
37 mammals have their own set of biases. For instance, stomach contents from an individual animal
38 may represent an accumulation of a number of meals over an extended period of time since
39 certain prey parts such as squid beaks or large fish bones get trapped in stomach folds where they
40 digest very slowly, or accumulate until regurgitated. The scat remains from that same animal
41 however, typically represent meals eaten 12 - 72 hours prior and tend to underrepresent the size
42 of prey consumed since small items pass through the digestive tract much more readily than large
43 items. A recent analysis of prey remains from stomachs and colons of northern fur seals
44 (Sinclair, unpubl. analyses) illustrates the potential bias in basing diet studies on either stomachs
45 or scats alone. Scat is a valuable tool for quantifying trends in predator diets, but is limited in
46 terms of discrete evaluation of absolute volumes or biomass of prey eaten. Nonetheless, scat is a
47 reliable tool for monitoring seasonal and temporal trends in predator diets and eliminates the
48 need to euthenize the animal.

1 The relative “importance” of an individual prey species in the diet of Steller sea lions is based on
2 the number of scats that contain that prey species and is referred to as “percent frequency of
3 occurrence” (%FO), or “percent occurrence”. The FO is calculated by dividing the number of
4 scats in which a prey item occurred by the total number of scats that contained identifiable prey.
5

6 The scat data were analyzed site by site across the Gulf of Alaska and Aleutian Islands. Then for
7 comparative purposes, rookery and haulout sites were grouped into regions based on population
8 trends (York et al. 1996): (i) western Gulf of Alaska (WGOA); (ii) eastern Gulf of Alaska
9 (EGOA); (iii) eastern Aleutian Islands (EAI); (iv) western Aleutian Islands (WAI). The data
10 were also compared seasonally: December - April collections (winter); May - September
11 collections (summer). FO was then calculated for each species within each region-season
12 grouping.
13

14 ***Prey species and relative importance to Steller sea lions***

15
16 A total of 3,852 scats collected between 1990 and 1998 contained identifiable prey remains. Of
17 those scats, 2,168 were collected between May and September (summer) and 1,684 were
18 collected between December and April (winter). Winter scat collections occurred only after
19 1993.
20

21 Year-round, all regions combined, walleye pollock and Atka mackerel are the two dominant prey
22 followed by Pacific salmon (Salmonidae) and Pacific cod (Fig. 4.6). The occurrence of walleye
23 pollock is highest in the Gulf of Alaska and eastern Aleutian Islands, becoming less important
24 moving west along the Aleutian Islands chain where it is replaced by Atka mackerel.
25

26 When FO is examined seasonally by region, several trends appear (Table 4.5). Pacific cod
27 consumption is highest during winter months within the Gulf of Alaska area (FO = 29%, CGOA;
28 FO = 37%, WGOA). Pacific cod also occurs during summer months, but at lower frequencies
29 overall. In contrast, the FO values for salmon range between 34 - 46% in the eastern regions
30 (CGOA, WGOA and EAI) during summer months, decreasing to 10 - 18% FO during the winter.
31 The occurrences of Pacific sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea*
32 *pallasii*) are also highest in the eastern regions however, frequencies of occurrence values are
33 comparable between winter and summer. Arrowtooth flounder (*Atheresthes stomias*) is most
34 prevalent in scats in the CGOA region (winter FO = 20.4; summer FO = 35.1) and cephalopods
35 (squid and octopus) are most prevalent in the CAI region (winter FO = 13.1; summer FO = 21.8).
36

37 Inter-island comparisons of diet on a seasonal basis demonstrates that some “minor” prey species
38 have consistently high FO values on particular islands, yet when FO values are averaged across a
39 region these same species may not rank among the top prey (Fig. 4.7). Examples of fish species
40 occurring among the top three prey items only on select islands during winter include: snailfish
41 (Liparididae) on Atkins and Sequam islands; rock greenling (*Hexagrammos lagocephalus*) on
42 Ulak Island; kelp greenling (*Hexagrammos decagrammus*) on Adugak Island; sandfish
43 (*Trichodon trichodon*) on Ugamak Island; and rock sole (*Lepidopsetta bilineata*) on Clubbing
44 Rocks. Species occurring among the top three prey only on specific islands during the summer
45 include: sand lance (*Ammodytes hexapterus*) on Atkins and nearby Pinnacle Rocks; and northern
46 smoothtongue (*Leuroglossus schmidti*) on Bogoslof Island (data are, however, limited to summer
47 only on Bogoslof). Relative values among the primary prey species also demonstrates wide
48 variation in relative importance between islands. Pacific cod, for instance is a significant prey
49 item during the winter in the Gulf of Alaska, however percent FO values range as low as 0 and

1 as high as 62 between sites there (Fig. 4.7).
2

3 The current diet of Steller sea lions based on year-round scat collections from the Gulf of Alaska
4 and Aleutian Island rookeries consists primarily of groundfish species walleye pollock, Atka
5 mackerel, and Pacific cod. Other groups that are important overall include the flatfishes
6 (Pleuronectidae) and sculpins (Cottidae), pelagic salmonidae, and cephalopods. Other species
7 such as sand lance and herring are present in the overall diet, but currently occur at relatively low
8 frequencies overall. When seasonal and spatial patterns are taken into account, the importance of
9 still other prey species, as measured by their frequencies of occurrence, becomes apparent.
10 Seemingly minor prey species may play a very important role in the foraging success of regional
11 populations of Steller sea lions and their young.
12

13 The results of this analysis differ significantly from those conducted prior to the mid-1970s.
14 Studies conducted in the Gulf of Alaska between 1958 and 1968 did not identify pollock as a
15 significant component of Steller sea lion diet (Mathisen et al., 1962; Thorsteinson and Lensink,
16 1962; Fiscus and Baines, 1966). The most common prey items in these earlier studies included:
17 cephalopods, greenlings (Hexagrammidae), rockfishes, smelts, capelin, and sand lance. Capelin,
18 which were important in Steller sea lion diet through the 1970's (Fiscus and Baines, 1966;
19 Pitcher, 1981) do not have an occurrence greater than 5% in this study. Salmon was present in
20 early studies but, not at the frequencies found across the range during the summer in this study.
21 The occurrence of flatfish, especially arrowtooth flounder, in the CGOA region is substantially
22 higher in this study than any previous studies have shown. Cephalopods were among the top
23 prey items found in Steller stomachs in many early studies (Mathisen et al., 1962; Thorsteinson
24 and Lensink, 1962; Pitcher, 1981; Merrick and Calkins, 1996) sometimes ranking as the most
25 frequently occurring prey item (Fiscus and Baines, 1966). Cephalopod occurrence was primarily
26 limited to the CAI and WAI regions and highest during the summer months, but never reached
27 the high frequencies of the 1960s.
28

29 The high occurrence of pollock in the diet in this study is comparable to diet studies conducted
30 between 1975 and 1993 (Pitcher, 1981; Merrick & Calkins, 1996; Merrick et al., 1997). This
31 study also highlights the importance of Pacific cod in Steller sea lion diet during the winter
32 months. Prior to this work, relatively few papers have focused on winter diet, so it is difficult to
33 assess whether this is a recent trend. Pacific cod was shown to be a top prey item (FO =12%) in
34 stomachs collected in the Gulf of Alaska 1973 - 1975 (Pitcher, 1981).
35

36 **Prey size**

37

38 Prey size was initially estimated based on subjective comparisons with museum reference
39 collections. In order to quantify prey body size, special studies were conducted for each of the
40 three primary prey species; Pacific cod (*Gadus macrocephalus*), Atka mackerel (*Pleurogrammus*
41 *monopterygius*) and walleye pollock (*Theragra chalcogramma*). NMFS has previously
42 developed a summary of studies used to develop regression analyses to quantify the body size of
43 Pacific cod, Atka mackerel, and walleye pollock. Regression formulae were then developed
44 based on a size-stratified series of selected bones. Ultimately, up to five measurable bone types
45 providing a high degree of correlation with total fish length (r^2 ranging 0.966 - 0.990) were
46 selected for each species. The 10 year database was then re-analyzed with application of these
47 new techniques. The results of these studies indicate that there is an overlap between the size of
48 prey consumed by Steller sea lions and the size of the fish taken by the commercial fisheries
49 although the extent of overlap could not be quantified in a manner that resulted in a precise

1 statement of overlap other than it does occur.

2 3 **4.8.6.5 Prey availability and foraging success**

4
5 The foraging success of a sea lion clearly depends on the availability of prey. For a given sea
6 lion, the availability of prey is determined by, among other things, the types of prey within the
7 foraging distribution of the sea lion, their standing biomasses, their characteristics, and their
8 spatial and temporal distributions. The diversity of prey selected by sea lions may also be a
9 determinant of their foraging success.

10 11 **Prey species or types**

12
13 A description of the prey species for Steller sea lions is described above in section 4.8.6.4.

14 15 **Prey biomasses**

16
17 Total prey biomass is determined by the sum of the biomasses of each different prey type in the
18 foraging distribution of a sea lion. For any particular prey type, available biomass changes as a
19 function of reproduction and recruitment, and physical growth of individual prey. Biomass
20 decreases as a function of natural and fisheries mortality, and as a function of life history events
21 such as spawning. At present, our best estimates of prey biomasses are derived from surveys of
22 groundfish stocks. These surveys generally provide “global” as opposed to “local” estimates of
23 biomass at a given point in time (summer) for large areas such as the eastern Bering Sea shelf or
24 the GOA. Although some efforts are now being made to derive prey biomass estimates at
25 seasonal scales inside and outside of critical habitat (NMFS 2000, in Appendix 3).

26 27 **Prey characteristics**

28
29 Examples of important prey characteristics include tissue or body composition, individual size
30 (mass), depth in the water column, degree of association with the bottom, and reproductive
31 physiology and behavior. Body composition determines the relative nutritional and energetic
32 value of a particular prey type, and individual prey size will determine the absolute gain in
33 nutrients and energy from predation on that prey (and whether such predation is feasible). Depth
34 in the water column determines whether the prey is accessible to sea lions. Degree of association
35 with the bottom may determine the vulnerability of prey to sea lions, and the type of foraging
36 strategy (or behavior) necessary for capturing such demersal prey. Reproductive physiology may
37 determine prey condition and nutritional value (e.g., pollock ripe with roe must be more valuable
38 to sea lions than pollock spent after the reproductive season). Taken together, these (and other)
39 characteristics determine the complicated and poorly understood predator-prey dynamics of
40 Steller sea lions and their fish prey which, in turn, determine the foraging success of sea lions.

41 42 **Spatial and temporal distributions**

43
44 The spatial and temporal distributions of prey types also must be a critical determinant of their
45 availability to sea lions. Many sea lion prey (Atka mackerel, cod, herring, pollock, and salmon)
46 occur in patchily distributed aggregations, particularly for reproduction. Important patch
47 characteristics may include their size, location, persistence, composition (e.g., prey sizes),
48 density (number of patches per area), and seasonality. Sea lions may alter their foraging strategy
49 as different prey species aggregate for reproduction or other purposes, filling the interim periods

1 with the best available prey. That is, they may exhibit pulses in foraging that allow them to take
2 advantage of the seasonal changes in availability of schools of Atka mackerel, cod, herring,
3 pollock, salmon, and other prey. These seasonal pulses may be essential for regaining good
4 condition or preparation for periods when desirable prey are less available and less desirable prey
5 must constitute the staple of their diet. Unfortunately, the information available to characterize
6 such prey patches and evaluate their potential importance to sea lions is limited. For many
7 species (e.g., pollock, cod), the available information is limited to trawl and hydroacoustic
8 surveys that generally provide a single broad-scale snapshot of prey distribution on an annual or
9 less frequent basis.

10 **Prey diversity**

11
12
13 The quality of the sea lion diet may be determined not only by the individual components
14 (species) of the diet, but also by the mix or diversity of prey in the diet. Merrick et al. (1997)
15 found a correlation between a measure of diet diversity in different geographic regions of the
16 western population and population trends in those regions. Their conclusions were that reliance
17 on a single prey type may not be conducive to population growth; a diversity of prey may be
18 necessary for recovery of the western population. Trites (unpubl. data) evaluated the diet and
19 population growth data for Steller sea lions in southeast Alaska and found results consistent with
20 those of Merrick et al. (1997). However, diet diversity is a function not only of prey selection,
21 but of the diversity of prey available. To the extent that pollock or Atka mackerel currently
22 dominate the prey field, sea lions survive on those prey. In addition, the analysis reported by
23 Merrick et al. (1997) and Trites did not account for the confounding factor that species diversity
24 of marine fish may decline from the eastern Gulf of Alaska to the western Aleutians. This is an
25 important caveat that remains to be fully analyzed.

26 **4.8.6.6 Foraging - integration and synthesis**

27
28
29 While much remains to be learned about Steller sea lions, the available information is sufficient
30 to begin a description of their foraging patterns. The emerging picture appears to be that:

- 31
32 • Steller sea lions are land-based predators but their attachment to land and
33 foraging patterns/distribution may vary considerably as a function of age, sex,
34 site, season, reproductive status, prey availability, and environmental conditions;
35
- 36 • foraging sites relatively close to rookeries may be particularly important during
37 the reproductive season when lactating females are limited by the nutritional
38 requirements of their pups;
39
- 40 • Steller sea lions appear to be relatively shallow divers but are capable of (and
41 apparently do) exploit deeper waters (e.g., to beyond the shelf break);
42
- 43 • at present, pollock and Atka mackerel appear to be their most common or
44 dominant prey, but Steller sea lions consume a variety of demersal, semi-
45 demersal, and pelagic prey;
- 46
47 • the availability of prey to an individual sea lion is determined by a range of
48 factors, including prey types within the foraging distribution of the sea lion, total
49 prey biomass, characteristics of the different prey types, and their spatial and

1 temporal distributions;

- 2
- 3 • diet diversity may also be an important determinant of foraging success and
- 4 growth of Steller sea lion populations; and
- 5
- 6 • the broad distribution of sea lions sighted in the POP database indicates that sea
- 7 lions forage at sites distant from rookeries and haulouts; the availability of prey
- 8 at these sites may be crucial in that they allow sea lions to take advantage of
- 9 distant food sources, thereby mitigating the potential for intraspecific
- 10 competition for prey in the vicinity of rookeries and haulouts.
- 11

12 The question of whether competition exists between the Steller sea lion and BSAI or GOA
13 groundfish fisheries is a question of sea lion foraging success. For a foraging sea lion, the net
14 gain in energy and nutrients is determined, in part, by the availability of prey or prey patches it
15 encounters within its foraging distribution. Competition occurs if the fisheries reduce the
16 availability of prey to the extent that sea lion condition, growth, reproduction, or survival are
17 diminished, and population recovery is impeded. The question of whether competition occurs
18 will be addressed in the Effects of the Action, Section 6.

19 20 **4.8.7 Physiology**

21 Studies of Steller sea lion physiology were initiated in the early 1990s in an effort to determine causes for
22 the observed declines and to provide indices of sea lion health. These studies were designed to compare
23 populations in decline areas to stable areas as well as to initiate captive studies to form a baseline of
24 physiological functions. An additional suite of captive studies have sought to explore the nutritional
25 limitation hypothesis by examining nutritional physiology. A summary of these studies follow, part of
26 which is excerpted from a Steller Sea Lion Recovery Team sponsored workshop on physiology held in
27 Seattle, Washington, on February 8-10, 1999.

28 29 30 **4.8.7.1 Captive studies**

31 The Steller sea lion captive research program at the University of British Columbia uses a
32 bioenergetic paradigm to empirically test hypotheses related to the population decline. Various
33 studies have examined the effect of prey type and intake rate on assimilative and digestive
34 efficiencies, body mass, metabolic rates, and the heat increment of feeding (Rosen and Trites
35 1997, 1999, 2000a, 2000b), and other studies examined the metabolic effect of fasting (Rea et al.
36 2000). Growth data, including body mass, multiple girth measurements, body length, and
37 blubber depth have been collected to document growth patterns, compose energy budgets, and to
38 evaluate the accuracy of using condition indices with wild sea lions.

39
40 Measurements of resting metabolism suggests a rapid decrease in mass-corrected metabolism
41 within the pup's first year, followed by a much more gradual decrease. This latter period is
42 characterized by increasing seasonal variation associated with changes in food intake and
43 activity, and critical life history phases (breeding and molting periods). Controlled fasting
44 experiments were conducted on captive Steller sea lion pups and juveniles to determine if sea
45 lions exhibit biochemical adaptation to fasting, and to determine if blood chemistry profiles can
46 be reliably used to judge nutritional condition of free-ranging Steller sea lions. These studies
47 suggest an age-related difference in how body reserves are utilized during fasting or how the
48 resulting products are circulated and used (Rea et al . 1998b; 2000). Four Steller sea lion pups
49

1 were fasted for 2.5 days to determine how pups mobilize energy reserves during short periods of
2 fasting similar to those experienced in the wild. Six-week-old Steller sea lion pups showed
3 evidence of rapid metabolic adaptation to fasting but were not able to sustain a protein-sparing
4 metabolism for a prolonged period at this age. These data suggest that pups were reverting to
5 protein metabolism after only 2.5 days of fasting, which infers a decrease in lipid catabolism
6 possibly due to depletion of available lipid resources.
7

8 To calculate the net energy available from different meal types and sizes, the heat increment of
9 feeding (HIF) and digestive (and assimilation) efficiency have been measured (see also Fadely et
10 al. 1994 for similar studies on California sea lions). Digestive efficiencies were found to be
11 positively related to prey energy content (Rosen and Trites 2000a), but unrelated to meal size or
12 feeding frequency (Rosen et al. 2000). For similarly sized meals, the energy lost through HIF (as
13 a percent of gross energy intake) was 11.9% for herring, 15.7% for pollock, and 19.4% for squid
14 (Rosen and Trites 1997, 1999), and increased with meal size (Rosen and Trites 1997). The
15 results indicate that the net energy difference in prey items is greater than that calculated solely
16 from gross energy density measurements (Rosen and Trites 2000b).
17

18 Short-term diet switches (2-3 weeks) from herring to a lower energy density prey (salmon, squid,
19 pollock) have also been carried out (Rosen and Trites, 2000b). Despite being fed ad libitum, the
20 sea lions failed to significantly increase ingested food mass when eating the lower energy diet,
21 resulting in significantly lower gross energy intakes and increased body mass loss (-1.1 kg/d
22 squid diet, - 0.6 kg/d pollock diet). Concurrent with the loss in body mass was progressive
23 metabolic depression indicating that the animal was entering a physiological state of increased
24 energy conservation. These metabolic adjustments were also seen in experimentally fasted sea
25 lions (Rea et al. 2000). A similar diet study at the Alaska Sea Life Center is currently attempting
26 to extend this short-term diet study by examining the effects of varying diet on sea lion health
27 over an annual time frame and by using a diet regime more closely linked to the sea lion diet in
28 the Gulf of Alaska.
29

30 **4.8.7.2 Free-ranging studies**

31
32 Body condition, blood chemistry and hematology have been examined in over 200 free-ranging
33 Steller sea lion pups to test the hypothesis that pups less than one month of age were nutritionally
34 or physiologically compromised such that they may be unable to survive the nursing period. The
35 results of these studies suggest that blood chemistry and body morphology show no indication
36 that sea lions less than one month of age from areas of population decline were nutritionally
37 compromised (Rea et al.1998).
38

39 Biochemical and physiological profiles also have been used to assess nutritional status and body
40 condition (M.A. Castellini, Institute of Marine Science, University of Alaska Fairbanks,
41 unpublished data). The study attempted to apply models of mammalian fasting and starvation to
42 compare Steller sea lions from declining and stable populations using morphometrics and blood
43 chemistry. By these measures, animals from the declining population were expected to be both
44 distinct and compromised. Measurements of body girth and length were taken, and body mass
45 was projected using the volumetric methods. Hematocrit, percentage body water, and a variety
46 of blood chemistry parameters were measured from animals sampled during the breeding season.
47 For comparison, blood chemistry profiles were also obtained from three captive juvenile sea
48 lions. Results did not match expectations. Animals from the western population were generally
49 rounder, longer, and heavier. Body water percentages were significantly lower for the western

1 group, implying the presence of more body fat. Hematocrit values were not significantly
2 different. Similarly, blood chemistry values did not provide evidence of nutritional stress,
3 especially when compared with captive animals, for sea lions during the breeding season.
4 However, Zenteno-Savin et al. (1997) did find elevated plasma concentrations of haptoglobin (an
5 acute phase protein that increases in concentration in response to chronic stress) in sea lions
6 sampled from the Aleutian Islands, Gulf of Alaska and Prince William Sound relative to those
7 sampled from Southeast Alaska or captivity.
8

9 Studies to assess maternal investment and energy metabolism of lactating females and pups have
10 been conducted by researchers at Texas A&M University. These studies attempted to compare
11 milk and energy intake rates for pups in areas of decline with those in a stable population.
12 Between 1991 and 1997, blood samples were obtained from 40 newborn pups at five rookeries.
13 The results of this study showed no significant differences in milk or energy intake among
14 declining or stable populations. She concluded that in early lactation when the pup's mass is
15 small relative to maternal mass, a lactating female's ability to adequately provision her young
16 may not be influenced by prey availability unless she experiences severe malnutrition. However,
17 the capacity of lactating females to "buffer" their young by mobilizing body reserves into milk is
18 limited and as the energetic demands of the pup increase, females will need to increase food
19 intake. During mid to late lactation, when the milk consumption by the pup is at a peak, females
20 may be unable to adequately provision their offspring if they do not have access to sufficient
21 prey. Interestingly, the milk content of lactating females from declining and stable Steller sea
22 lion populations was also examined and found no significant differences among locations in any
23 milk component except protein, which may be explained by the small sample sizes.
24

25 Another important component of Steller sea lion physiology is their ability to regulate body
26 temperatures in both aquatic and terrestrial environments (thermoregulation) which has been
27 studied by T. Williams at the University of California, Santa Cruz. Steller sea lions are highly
28 specialized mammals that spend much of their lives at sea. To counterbalance the high thermal
29 conductivity of water, Steller sea lions, like many marine mammals, have developed a thick
30 insulating blubber layer that encases the body. Maintenance of this insulating layer depends on
31 an appropriate diet for the deposition of lipids that comprise the blubber. Williams' study
32 compared thermal profiles and quality of insulation for Steller sea lions from declining (Chirikof
33 Island, Aleutian Islands, Marmot Island) and stable (Lowrie Island) populations in Alaska.
34 Preliminary results suggest that blubber thickness in adult females is comparatively lower for
35 animals in the declining areas. Pups showed similar trends for blubber thickness; however,
36 differences in heat flow and insulation quality between the areas of decline and stability were not
37 as distinct as observed for the adults. These results indicate subtle differences in insulation
38 between Steller populations. Interestingly, these differences were not apparent with courser
39 morphological measurements such as length-girth relationships and body mass.
40

41 **4.8.7.3 Direction for physiological studies**

42

43 The review panel convened by the Steller Sea Lion Recovery Team provided recommendations
44 for future physiological efforts on Steller sea lions. These recommendations included
45 development of a research framework under which the recovery of Steller sea lions can be
46 considered in a broader ecological context, including the development of a multidisciplinary
47 bioenergetics model. The panel also suggested that the NMFS Steller sea lion research
48 coordinator implement both a Strategic Plan for research and an external peer review process for
49 that plan to provide better coordination and accountability for Steller sea lion research. The

1 panel felt that it was now time to move into a phase of more manipulative experimental designs
2 involving free-ranging Steller sea lions. In this context, it was felt important to reconcile what
3 researchers can do now with what they should be doing in the future to promote Steller sea lion
4 recovery. Although initial studies have been completed, the panel recommended investigations
5 into the responses of Steller sea lions to starvation and limited diets using physiological studies
6 on captive animals. The panel also felt that improved imaging technology may enhance age
7 structure analysis of populations, and lastly, the panel highly recommended the development of a
8 reliable, inexpensive index of body condition. Body composition (protein + fat) is the best
9 measure of body condition, but it is also the most expensive to measure. Pitcher et al. (unpubl)
10 evaluated various morphometric measures as indices of fatness for Steller sea lions, and found
11 that, though such indices could account for up to 75% of the variation in sea lion fatness and
12 were useful for population-level comparisons, such indices were not adequate to evaluate the
13 condition of an individual. A quick and reliable way to assess condition is required. Both
14 NMFS, ADFG, and other parties are presently addressing this and the other recommendations
15 provided by the review panel.
16

17 Direct detection of stressed or nutritionally limited individual sea lions in the wild is difficult.
18 Though thousands of mortalities occur annually, very few carcasses are found to necropsy,
19 precluding a direct determination of cause of death. Also, animals breeding at rookeries (and
20 thus available for sampling) are perhaps less likely to be in poor health since they are in
21 sufficient condition to attempt territorial defense (males) or carry a pup to term (females). This
22 does not mean, however, that differences in condition between entire populations or areas can
23 not be detected using health and body condition methods, as such differences have been detected
24 between areas and over time (Calkins et al. 1998).
25

26 According to the York (1994) model, only a 10-20% change in juvenile survival is required to
27 account for the decline. Since there may then only be a small increase in post-weaned juvenile
28 mortality, the statistical power to differentiate these potentially compromised individuals from
29 the 'normal' population is uncertain. Because only a relatively few individuals may be
30 compromised, the likelihood of sampling one from the general population is low. The likelihood
31 of detecting a compromised animal if one were to be sampled must also be considered. Blood
32 chemistry profiling and body condition measurements can detect severely or clinically
33 compromised animals, and can also be useful for broad spatial or temporal comparisons. Though
34 subclinical differences in health or condition can be detected, the relationship between these
35 indices and fecundity or survival has not been quantified. Pitcher et al. (unpubl) found that body
36 condition was positively related to the probability that a female would be pregnant during late
37 gestation.
38

39 **4.8.8 Natural predators**

40
41 The Recovery Plan for the Steller Sea Lion (NMFS 1992) states: "Steller sea lions are probably eaten by
42 killer whales and sharks, but the possible impact of these predators is unknown. The occurrence of shark
43 predation on other North Pacific pinnipeds has been documented, but not well quantified (Ainley et al.,
44 1981)." A major increase in sharks in the GOA has been documented in recent years. Killer whales are
45 likely predators in the waters of British Columbia and Alaska (Frost et al. 1992; Barrett-Lennard et al.,
46 unpubl. rep.). Regarding predation by killer whales on Steller sea lions, Frost et al. (1992) reported that
47 an unusual number of killer whales appeared inshore in waters of the southeastern Bering Sea in the
48 summers of 1989 and 1990. Multiple sightings of killer whales were reported from Bristol Bay and the
49 Kuskokwim Bay, where killer whales had been seen only rarely in previous years. Of the 27 reported

1 sightings in 1989 and 1990, one sighting of 4 whales near Round Island involved chasing of a Steller sea
2 lion. A more detailed discussion on the impacts of killer whale predation on Steller sea lions is presented
3 in the Baseline (see section 5.2).

4 5 **4.8.9 Natural competitors**

6
7 Competition may take several forms. For exploitative competition to occur, the potential competitors
8 must use the same resource, the availability of that resource must be limited relative to the needs of at
9 least one of the potential competitors, and use of the available resource by one competitor must impede
10 availability to the other, to its detriment (Krebs 1985). Interference competition can occur even when
11 resources are not limited if the use of the resource by one potential competitor harms another. With
12 respect to other (nonhuman) species, Steller sea lions are most likely to compete for food, although they
13 may also compete for habitat (e.g., potential competition with northern fur seals for rookery or haulout
14 space).

15
16 Steller sea lions forage on a variety of marine prey that are also consumed by other marine mammals
17 (e.g., northern fur seals, harbor seals, humpback whales), marine birds (e.g., murre and kittiwakes), and
18 marine fishes (e.g., pollock, cod, arrowtooth flounder). To some extent, these potential competitors may
19 partition the prey resource so that little direct competition occurs. For example, harbor seals and
20 northern fur seals may consume smaller pollock than Steller sea lions (Fritz et al. 1995). Competition
21 may still occur if the consumption of smaller pollock limits the eventual biomass of larger pollock for sea
22 lions, but the connection would be difficult to demonstrate. Such competition may occur only seasonally
23 if, for example, fur seals migrate out of the area of competition in the winter and spring months.
24 Similarly, competition may occur only locally if prey availability or prey selection varies geographically
25 for either potential competitor. Finally, competition between sea lions and other predators may be
26 restricted to certain age classes, as diet may change with age or size.

27 28 **4.8.10 Disease**

29
30 Parasites known to infect sea lions include cestodes of the genera *Diplogonoporus*, *Diphyllobothrium*,
31 *Anophryocephalus*, *Adenocephalus*, and *Pyramicocephalus*; trematodes of the genera *Pricetrema*,
32 *Zalophotrema*, and *Phocitrema*; acanthocephalans of the genera *Bulbosoma* and *Corynosoma*; and
33 nematodes of the genera *Anisakis*, *Contraecaecum*, *Parafilaroides*, *Uncinaria*, and *Phocanema* (Hill 1968,
34 Dailey and Brownell 1972, Daily 1975, Fay et al. 1978, Geraci 1979, Dieterich 1981, Hoover 1988). In
35 addition, Thorsteinson and Lensink (1962) reported two types of parasites: Body louse (*Antarctophthirus*
36 *michrochir*) severely infesting pups and nose mites (*Orthohalarachne diminuta*) invariably found on
37 adults. And Scheffer (1946) reported ascarid worms (*Porocaecum decipiens*) nearly always found in
38 adult stomachs.

39
40 Sea lion exposure to disease has been documented by evidence of leptospirosis (Fay et al. 1978),
41 chlamydiosis (Goodwin and Calkins 1985), and San Miguel sea lion virus (Goodwin and Calkins 1985,
42 Barlough et al. 1987). Barlough et al. (1987) also present evidence of eight types of calici virus
43 (including seven types of San Miguel sea lion virus and Tillamook [bovine] virus). And recent tests,
44 indicate exposure to brucellosis (pers. comm., K. Pitcher, ADFG). Disease may have contributed to the
45 high fetal mortality rate observed in animals collected in 1975–1978 and 1985–1986 (Pitcher et al. in
46 review) but, again, that hypothesis is not substantiated by available data.

47
48 While a range of different parasites, diseases, and maladies have been documented for Steller sea lions,
49 the available evidence is not sufficient to demonstrate that these have played or are playing any

1 significant part in the decline of the western population.

2 3 **4.8.11 Population distribution** 4

5 The breeding range of the Steller sea lion covers virtually all of the North Pacific Rim from about 34° N
6 to 60°N lat. Within this range, sea lions are found in hundreds of rookeries and haulouts. These rookery
7 and haulout sites can be grouped in rookery/haulout clusters on the basis of politics, geography,
8 demographic patterns, genetics, foraging patterns, or other reasons related to scientific study or
9 management. Political divisions are drawn to separate animals that are found off Japan or the Republic
10 of Korea, in Russian territories, in Alaska, British Columbia, or along the western coast of Washington,
11 Oregon, and California. These divisions are largely for the purpose of management or jurisdiction, but
12 may be related to sea lion population dynamics because of differing management strategies or objectives.
13

14
15 Geographic distinctions are frequently made on the basis of variable habitat or ecosystem characteristics
16 in differing parts of the range. For example, rookeries and haulouts in the Aleutian Islands are often
17 separated from those in the GOA, and these two areas are again separated from southeastern Alaska and
18 British Columbia. These distinctions may have demographic significance because of the important
19 variability in ecosystem features such as prey resources.
20

21 Sea lion rookeries and haulouts are also grouped on the basis of observed demographic trends
22 (York et al. 1996). Many, if not most, descriptions of the decline of Steller sea lions begin with the
23 statement that the decline was first witnessed in the eastern Aleutian Islands in the mid 1970s and then
24 spread westward to the central Aleutian Island and eastward to the western GOA in the late 1970s and
25 early 1980s. Similarly, counts are frequently presented for the area from Kenai to Kiska Island, which is
26 considered to enclose the center of abundance for the species. Genetic studies (Bickham et al. 1996,
27 Loughlin 1997) provided the basis for distinguishing western and eastern management stocks of the sea
28 lion, and additional work may allow further differentiation of stocks. The relation between diet diversity
29 and population trend was studied using rookery groups identified by geographic location and rates of
30 change. The rookery groups were those identified by York et al. (1996). These examples indicate that,
31 depending on the purpose at hand, the total sea lion population may be split meaningfully into
32 subpopulations in any number of ways.
33

34 However, if the purpose is to study or understand the natural (i.e., without human influence) population
35 structure of the Steller sea lion, then the biogeography of the species must be defined more narrowly.
36 Genetic studies may provide the best description of the result of biogeographic patterns, as they are likely
37 the least influenced by human interaction. Demographic trends and foraging patterns may be influenced
38 by human activities and, clearly, the artificial boundaries determined for political purposes should not
39 have an influence on the natural biogeography of sea lions.
40

41 Natural factors that determine their biogeography include climate and oceanography, avoidance of
42 predators, distribution and availability of prey, the reproductive strategy of the species, and movement
43 patterns between sites. The marine habitat of the Steller sea lion tends to reduce variation in important
44 environmental or climatic features, allowing the sea lion to disperse widely around the rim of the North
45 Pacific Ocean. The decline of Steller sea lions off California may indicate a contraction in their range,
46 depending on the explanation for that decline. Avoidance of terrestrial predators must clearly be an
47 important factor, as rookeries and haulouts are virtually all located at sites inaccessible to such predators.
48 Distribution and availability of prey are likely critical determinants of sea lion biogeography, and
49 probably determine the extent of their dispersion during the non-reproductive season. The reproductive

1 strategy of the species, on the other hand, requires aggregation at rookery sites, and therefore likely
2 places important limits on the species' movement patterns and dispersion. Finally, movement patterns
3 between sites determine, in part, the extent to which such groups of sea lions at different rookeries and
4 haulout sites are demographically independent. Steller sea lions are generally not described as migrators.
5 Adult males, for example, are described as dispersing widely during the non-reproductive seasons, and
6 juveniles are described as dispersing widely after weaning and not returning to the reproductive site until
7 they are approaching reproductive age (Calkins and Pitcher 1982).

8 9 **4.8.12 Population Status and Trends**

10
11 Assessments of the status and trends of Steller sea lion populations are based largely on (a) counts of
12 nonpups (juveniles and adults) on rookeries and haulouts, and (b) counts of pups on rookeries in late
13 June and early July. Both kinds of counts are indices of abundance, as they do not necessarily include
14 every site where animals haul out, and they do not include animals that are in the water at the time of the
15 counts. Population size can be estimated by standardizing the indices (e.g., with respect to date, sites
16 counted, and counting method), by making certain assumptions regarding the ratio of animals present
17 versus absent from a given site at the time of the count, and by correcting for the portion of sites counted.
18 Population estimates from the 1950s and 1960s (e.g., Kenyon and Rice 1961; see also Trites and Larkin
19 1992, 1996) are used with caution because counting methods and dates were not standardized, and the
20 results contain inconsistencies that indicate the possibility of considerable measurement error at some
21 sites in some years. Efforts to standardize methods began in the 1970s (Braham *et al.* 1980); as a result,
22 counts conducted since the late 1970s are the most reliable index of population status and trends.

23
24 For the western U.S. population (i.e., west of 144°W long.), index counts of adults and juveniles fell
25 from 109,880 animals in the late 1970s to 22,223 animals in 1996, a decline of 80% (Fig. 4.8; Table 4.6;
26 NMFS 1995, Strick *et al.* 1997, Strick *et al.* *in press*). In 2000, that number has further declined to
27 18,193 animals, an 18% decrease. In the GOA, from the late 1970s to 1996, index counts dropped from
28 40,042 to 9,789 (76%), and for the BSAI region dropped from 70,412 to 12,434 (82%). In the GOA,
29 from 1996 to 2000, index counts dropped from 9,789 to 7,853 (20%), and for the BSAI region counts
30 dropped from 12,434 to 10,340 (17%).

31
32 Counts in Russian territories (to the west of the action area for the BSAI and GOA groundfish fisheries)
33 have also declined and are currently estimated to be about one-third of historic (i.e., 1960s) levels
34 (NMFS 1992). Counts conducted in 1989, 1994, and 1999 indicate that the recent trends in counts in
35 Russia may vary considerably by area (V. Burkanov, pers. comm.). Counts have increased in the
36 northern part of the Sea of Okhotsk and at Sakhalin Island, but decreased at Kamchatka, Bering Island,
37 and the northern half of the Kurils. Whether these changes were due to births and deaths, or immigration
38 and emigration (i.e., a shift in distribution) is unknown. The data suggest that the number of pups born
39 may have increased over the last ten years at 2.7% annually. The sum of the counts conducted in 1989,
40 1994, and 1999 has increased over the last ten years, but counts at repeated sites have decreased,
41 indicating that trends in Russia can not yet be described with confidence. Nonetheless, relative to the
42 1960s, counts in Russia are depressed to a degree similar to that observed for the western population in
43 the U.S.

44
45 For the western population, the number of animals lost appears to have been far greater from the late
46 1970s to the early 1990s. Nevertheless, the rate of decline in the 1990s has remained relatively high: the
47 1996 count was 27% lower than the count in 1990, and the 2000 count was 18% lower than in 1996.
48 Review of counts by region also indicate a continued sharp rate of decline in some areas (Table 4.6). In
49 the eastern GOA, 7,241 nonpups were counted in 1989 and 2,133 were counted in 1996 – a loss of 71%

1 over a 7-year period, which is equivalent to a loss of about 15% annually. In the central GOA, counts
2 declined by 86% between 1976 and 1998; 55% from 1985 to 1989 (approximately 18% annually); and
3 61% from 1989 to 1998 (approximately 13% or more annually).
4

5 Counts of pups from the 2000 survey did not decline to the extent as nonpup counts. NMFS counted sea
6 lion pups at four rookeries in the eastern Aleutian Islands (Yunaska, Adugak, Bogoslof, Akun) and five
7 rookeries in the Gulf of Alaska (Pinnacle, Atkins, Chirikof, Outer I., and Fish I.) during 20 June to 6 July
8 2000. From 1998 to 2000, three rookeries decreased by a combined loss of 125 pups, two rookeries
9 increased by a combined total of 47 pups, and four rookeries showed no change. For these areas, the
10 numbers declined by about 3% to 4% between 1998 and 2000. However, the counters overall impression
11 was of no appreciable change in pup counts at these sites over the past two years, and they considered the
12 pups to appear relatively “healthy.”
13

14 In addition, the portion of (non-pup) sea lions counted on rookeries versus haulouts appears to have
15 declined considerably during the 1990s (Sease and Loughlin 1999, their Table 7). From 1998 to 2000,
16 non-pup counts declined by 13.8% as an average of all sea lion sites (John Sease, personal
17 communication, 2000) This decline could occur for a number of reasons: a decrease in reproductive rate
18 for females, a decrease in number of males on the rookeries, a shift in the age distribution from relatively
19 more mature animals to relatively fewer mature animals (such as might occur with greater juvenile
20 survival), or a shift in the timing of reproduction relative to the timing of the counts.
21

22 For the eastern population (east of 144°W long.), counts of nonpups (adults and juveniles) have increased
23 overall from just under 15,000 in 1982 to just over 20,000 in 1994 (Hill and DeMaster 1998). Counts of
24 nonpups in California/Oregon were essentially unchanged from 1982 to 1996 at about 3,300. In
25 California alone, the counts during this period represent a decline of over 50% since the first half of this
26 century (NMFS 1995). Counts of nonpups in British Columbia increased from 4,700 in 1982 to 8,100 in
27 1994. P. Olesiuk (pers. comm.) reports that the overall population trend in British Columbia over the
28 last 30 years has been an annual increase of 2% to 3%. The increase in British Columbia likely
29 represents partial recovery from the effects of “control” programs in the earlier part of the century. In
30 1913, after sea lion numbers had already been reduced, 10,000–12,000 animals (including pups) were
31 counted. In 1965, after continued efforts to reduce sea lion numbers, 4,000 were counted (Bigg, 1988).
32 More recently, counts of non-pups at trend sites in southeast Alaska have increased from 6,400 in 1979
33 to 8,700 in 1998 (NMFS 1995, Sease and Loughlin 1999). The number of pups born in southeast Alaska
34 increased from ca. 2,200 in 1979 to ca. 3,700 in 1994 (NMFS 1995). Pup production increased at Hazy
35 and Forrester Islands. Forrester Island has become the largest rookery for the entire species, with just
36 under 3,300 pups born there in 1991 (NMFS 1995).
37

38 **4.8.13 Population Variability and Stability** 39

40 Populations change as a function of births, deaths, immigration, and emigration. During the
41 nonreproductive season, some sea lions may move between the western and eastern populations (Calkins
42 and Pitcher 1981), but net migration out of the western population is not considered a factor in the
43 decline. Over the past two decades, the amount of growth observed in the eastern population is
44 equivalent to only a small fraction of the losses in the western population. Thus, the decline must be due
45 primarily to changes in birth and death rates. As mentioned above, computer modeling (York 1994) and
46 mark-recapture experiments (Chumbley et al. 1997) indicate that the most likely problem leading to the
47 decline is decreased juvenile survival, but lower reproductive success is almost certainly a contributing
48 factor. Finally, adult survival has not been characterized and even small changes in the survival rate of
49 adult females may be contributing significantly to past or current population trends.

1 These changes in vital rates would likely lead to changes in the age structure which, in turn, may tend to
2 destabilize populations. With declining reproductive effort or juvenile survival, populations tend to
3 become top heavy with more mature animals (e.g., the increase in mean age of adult females described by
4 York [1994]), followed by a drop in population production as mature animals die without replacement
5 through recruitment of young females. The extent to which the age structure is destabilized and the
6 effect on population growth rate depends, in part, on the length of time that reproduction and/or juvenile
7 survival remain suppressed. Increased mortality of young adult females may have the strongest effect on
8 population growth and potential for recovery, as these females have survived to reproductive age but still
9 have their productive years ahead of them (i.e., they are at the age of greatest reproductive potential).

10
11 Vital rates and age structures may change as a function of factors either extrinsic or intrinsic to the
12 population. This biological opinion addresses the question of potential effects of fishery actions (i.e.,
13 extrinsic factors) on the Steller sea lion. However, the potential effects will be determined, in part, by
14 the sensitivity of the western population to extrinsic influence, its resilience, and its recovery rate. The
15 Steller sea lion fits the description of a “K-selected” species of large-bodied, long-lived individuals with
16 delayed reproduction, low fecundity, and considerable postnatal maternal investment in the offspring.
17 These characteristics should make sea lion populations relatively tolerant of large changes in their
18 environment. Thus, the observed decline of the western population over the past two to three decades is
19 not consistent with the description of the species as K-selected, and suggests that the combined effect of
20 those factors causing the decline has been severe. The ability of the population to recover (i.e., its
21 resilience) and the rate at which it recovers will be determined by the same K-selected characteristics
22 (longevity, delayed reproduction, and low fecundity), as well as its metapopulation structure. Its
23 maximum recovery rate will likely be limited to no more than 8% to 10% annually (based on its life
24 history characteristics and observed growth rates of other Otariids), which means that recovery could
25 require 20 to 30 years, even under optimal conditions. The metapopulation structure of the western
26 population may enhance or deter recovery. Dispersal of populations provides some measure of
27 protection for the entire species against relatively localized threats of decline or extinction. And
28 rookeries that go extinct may be more likely recolonized by seals migrating between sites. On the other
29 hand, the division of the whole population into smaller demographic units may exacerbate factors that
30 accelerate small populations toward extinction (e.g., unbalanced sex ratios, allee effects, inbreeding
31 depression). Such acceleration has been referred to as an “extinction vortex” (Gilpin and Soulé 1986).

32
33 Finally, any description of population stability for the Steller sea lion should be written with caution.
34 Over the past three decades (or perhaps longer), we have witnessed a severe decline of the western
35 population throughout most of its range. Our inability to anticipate those declines before they occurred,
36 our limited ability to explain them now, and our limited ability to predict the future suggests the
37 difficulty of describing the stability of Steller sea lion populations.

38 39 **4.8.14 Population Projections**

40
41 Based on recent trends in southeast Alaska and British Columbia, prospects for recovery of the eastern
42 population are encouraging. Population viability analyses have been conducted for the western
43 population by Merrick and York (1994) and York et al. (1996). The results of these analyses indicated
44 that the next 20 years would be crucial for the western population of Steller sea lions, if the rates of
45 decline observed at that time were to continue. Within this time frame, they determined the possibility
46 that the number of adult females in the Kenai-to-Kiska region could drop to less than 5000. Extinction
47 rates for rookeries or clusters of rookeries could also increase sharply in 40 to 50 years, and extinction
48 for the entire Kenai-to-Kiska region could occur within 100–120 years. These projections have not been
49 updated since 1994, however, given the continued decline of sea lions at about 4-7% annually, we

1 consider the next 15years to be an important time period for Steller sea lions.

2
3 Further analysis of population projections is presented in the Baseline (see section 5.4.4).

4 5 **4.8.15 Listing status**

6
7 On 26 November 1990, the Steller sea lion was listed as threatened under the ESA. In 1997; the species
8 was split into two separate stocks on the basis of demographic and genetic dissimilarities (Bickham et al.
9 1996, Loughlin 1997); the status of the western stock was changed to endangered; and the status of the
10 eastern stock was left unchanged (62 FR 30772).

11 12 **4.9 Chinook Salmon**

13
14 Chinook salmon are the largest of the Pacific salmon and historically ranged from the Ventura River in
15 California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to
16 the Anadyr River in Russia (Healey 1991). In addition, chinook salmon have been reported in the
17 Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Six threatened or endangered
18 species of chinook salmon are known to occur in the action area for this consultation. Because of
19 similarities in the life history and threats to the survival and recovery of these six chinook salmon
20 covered in this biological opinion, we will begin this section by summarizing the general life history and
21 threats to chinook salmon. Then we will separately discuss specific information on their listing status,
22 population status and trends, and impacts that are not shared for each species.

23 24 **Life history information**

25
26 Chinook salmon exhibit diverse and complex life history strategies. Two generalized freshwater life-
27 history types were initially described by Gilbert (1912): “stream-type” chinook salmon reside in
28 freshwater for a year or more following emergence, whereas “ocean-type” chinook salmon migrate to the
29 ocean within their first year. For the purposes of this opinion, we will refer to chinook salmon (spring
30 and summer runs) that spawn upriver from the crest of the Cascade Range as “stream-type”; we will refer
31 to chinook salmon that spawn down-river of the crest of the Cascade Range (including in the Willamette
32 River) as “ocean-type.”

33
34 The generalized life history of Pacific salmon involves incubation, hatching, and emergence in
35 freshwater; migration to the ocean until they reach sexual maturity; and a migration to freshwater to
36 complete the maturation process and spawn. Juvenile salmon rear in freshwater for various lengths of
37 time and some male chinook salmon do not migrate to the ocean and mature in freshwater. The timing
38 and duration of these stages will be determined by genetics and the environment.

39 40 **Impacts of human activity on chinook salmon**

41
42 Over the past few decades, the size and distribution of chinook salmon populations have declined
43 because of natural phenomena and human activity. The following discussions briefly summarize the
44 effect of the hydropower system, harvests, hatcheries, and habitat degradation on the status of chinook
45 salmon in the Columbia and Snake River basins.

46 47 **Hydropower**

48
49 The network of dams, reservoirs, and diversions that comprise the hydropower system in the Columbia

1 River and Snake River basins has substantially reduced or eliminated populations of chinook salmon.
2 The hydropower system has increased water temperatures, changed the structure of freshwater fish
3 communities, and depleted flows necessary for salmon migration, spawning, rearing by flushing sediment
4 from spawning gravels, altering gravel recruitment, and eliminating the transport of large woody debris.
5 Physical features of dams, such as turbines and sluiceways, have increased the mortality of both adult
6 and juvenile salmon in the Columbia River basin. In some cases, the dams block access to spawning and
7 rearing habitat and have a direct effect on populations of chinook salmon. In other cases, the dams have
8 indirect effects on these salmon by increasing the number of adults and juveniles that are killed during
9 downstream and upstream migrations; changing natural flow regimes; de-watering or reduce flows to
10 downstream areas; and disrupting the movement of gravel necessary to maintain spawning sites.

11
12 Reservoirs associated with the hydropower system in the Columbia River Basin create ecological
13 conditions that are ideal for native, predatory fish and non-native fish species. The result has been
14 increased predation of juvenile chinook salmon. Predators such as northern pikeminnow (*Ptychocheilus*
15 *oregonensis*), walleye (*Stizostedion vitreum*), smallmouth bass (*Micropterus dolomieu*), and channel
16 catfish (*Ictalurus punctatus*) consume between 9 and 19 percent of the juvenile salmon entering
17 reservoirs, with northern pikeminnow accounting for about 78 percent of this loss.

18 **Harvests**

19
20
21 Many stock of chinook salmon were threatened by fishing pressure before their habitat was degraded.
22 Even after watersheds of western United States, were destroyed or degraded many populations of
23 chinook salmon were still being exploited at unsustainable rates. As a result of these threats, many
24 chinook salmon runs became extinct.

25
26 Between 1982 and 1989, total exploitation rates for chinook salmon in the Columbia River and Snake
27 River region averaged 68 percent, with ocean exploitation rates averaging 39 percent. After listing,
28 chinook salmon were still harvested, although at lower levels; ocean harvest rates were 11.5 percent in
29 1995 and 23 percent in 1996 (PFMC 1996). Because of their life history, ocean fisheries pose a
30 significant threat to salmon; even small ocean harvests of adult salmon can significantly reduce a salmon
31 population's likelihood of surviving and recovering in the wild. Nevertheless, threatened and endangered
32 salmon are caught in groundfish fisheries off Alaska, Washington, Oregon, and California.

33 **Hatcheries**

34
35
36 About 80 percent of the annual adult salmon that now return to the Columbia River Basin to spawn come
37 from a hatchery. Nearly all of the 100 or more hatcheries in the Columbia River basin were constructed
38 to compensate for the loss of fish and fish habitat that was caused by the hydropower system; together
39 they produce about 150 million salmon each year.

40
41 Hatcheries benefit native salmon by conserving natural populations in areas where habitat conditions can
42 no longer support natural spawning or where the numbers of returning adults are so low that a population
43 has an immediate risk of extinction. At the same time, hatcheries hurt natural populations of salmon
44 through interbreeding between hatchery and wild salmon (which can adversely affect the health of wild
45 salmon populations), predation by larger hatchery salmon on smaller wild salmon, competition between
46 hatchery and wild salmon for food and space, disease transmission, and by supporting mixed-stock
47 fisheries that target large populations of hatchery salmon may overharvest smaller populations of wild
48 salmon.

1 **Habitat**

2
3 Forestry, agriculture, mining, urbanization, grazing, flood control, dredging, water pollution, water
4 withdrawals, hydropower, road construction, and recreational activities have destroyed and degraded
5 aquatic and riparian ecosystems throughout the Columbia and Snake River basins. Examples of habitats
6 that have been destroyed in the region include riparian and aquatic ecosystems (in 1988, about 95% of
7 streams surveyed in Oregon has been moderately or severely degraded by excessive sedimentation, high
8 water temperatures, bank instability and other problems related to logging and removal of large woody
9 debris; FEMAT 1993), wetlands (reduced by 30 percent in Washington and Oregon; NMFS 1998), and
10 forests, which experienced significant changes in structure and composition after 50 years of even-age
11 timber management. In addition, water throughout large portions of the Pacific Northwest has been
12 diverted for agriculture, flood control, and domestic uses. Combined with the effects of the hydropower
13 system in the Columbia River basin, these habitat losses have had devastating effects on populations of
14 chinook salmon in Pacific Northwest.

15
16 Federal, state, and local governments in the Columbia River basin are undertaking several efforts to slow
17 or reverse the decline of chinook salmon populations that include the Northwest Forest Plan, PACFISH,
18 Lower Columbia River National Estuary Program, Lower Columbia Steelhead Conservation Initiative,
19 Oregon Plan for Salmon and Watersheds, Washington Wild Stock Restoration Initiative, and Washington
20 Wild Salmonid Policy.

21 **Natural phenomena**

22
23
24 Natural variations in freshwater and marine environments have substantial effects on the abundance of
25 salmon populations. Of the various natural phenomena that affect most populations of Pacific salmon,
26 changes in ocean productivity are generally considered most important. Recent evidence suggests that the
27 survival of Pacific salmon in the marine environment fluctuates in response to long-term cycles of
28 climatic conditions and ocean productivity (20–30 years); these fluctuations cause salmon survival to be
29 either above-average or below-average (Cramer 1999). These long-term, climactic fluctuations have
30 been referred to as the Pacific Decadal Oscillation. For many years, ocean conditions and resulting
31 productivity appear to have produced below-average marine survival rates for Pacific salmon, which has
32 reduced the size of salmon populations throughout the Pacific Northwest.

33
34 At the same time, the long-term survival of Pacific salmon depends on the productivity of freshwater
35 ecosystems, which determines the number of salmon that enter the ocean. During the early 1990s,
36 freshwater ecosystems throughout the Pacific coast were affected by a series of very dry years, which
37 adversely affected the survival of adult and juvenile salmon in those areas. More recently, severe
38 flooding throughout the Pacific Northwest has reduced the spawning success of salmon populations in
39 the region.

40
41 Chinook salmon are exposed to high rates of natural predation, particularly during freshwater rearing and
42 migration stages. Ocean predation probably contributes to significant natural mortality, although the
43 levels of predation are largely unknown. In general, chinook are prey for pelagic fishes, birds, and
44 marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns
45 that increasing size of tern, seal, and sea lion populations in the Pacific Northwest has dramatically
46 reduced the survival of adult and juvenile salmon in the Columbia River estuary.

47
48 **4.9.1 Puget sound chinook salmon**

1 **4.9.1.1 Species description and distribution**
2

3 Puget Sound chinook salmon include all runs of chinook salmon in the Puget Sound region from
4 the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. Chinook salmon
5 in this area generally have an “ocean-type” life history. Thirty-six hatchery populations were
6 included as part of the species and five were considered essential for recovery and listed
7 including spring chinook from Kendall Creek, the North Fork Stillaguamish River, White River,
8 and Dungeness River, and fall run fish from the Elwha River.
9

10 **4.9.1.2 Listing status**
11

12 Puget Sound chinook salmon were listed as threatened under the ESA in 1999. Critical habitat
13 has not been designated for these salmon.
14

15 **4.9.1.3 Population status and trends**
16

17 The largest recorded harvest of this species occurred in 1908, when the run-size for Puget Sound
18 chinook salmon was estimated at 690,000 fish (in 1908, both ocean harvests and hatchery
19 production were negligible). Between 1992 and 1996, the average run-size of natural chinook
20 salmon runs in North Puget Sound was about 13,000 fish. With few exceptions, these runs
21 represented short- and long-term declines.
22

23 **4.9.1.4 Impacts of human activity on this species**
24

25 Hatchery production sustains about 10 of 29 stocks of Puget Sound chinook salmon (WDF *et al.*
26 1993). Since the 1950s, nearly 2 billion salmon have been released from hatcheries into Puget
27 Sound tributaries; most of these chinook salmon were produced from local, fall-run, chinook
28 salmon. Since artificial propagation programs began, hatchery returns have accounted for more
29 than 57% of the total spawning escapement of this species.
30

31 The status of naturally-spawning, Puget Sound chinook salmon varies by stock. Of the 29
32 chinook stocks identified by WDF *et al.* (1993) 10 were classified as healthy, 8 as depressed, 4 as
33 critical, and 3 as unknown. The critical stocks are all spring-run chinook stocks. Although
34 problems associated with habitat degradation and hatchery influence are common to all stocks, at
35 least some stocks appear to be in reasonably good shape: in 1998 returns of adult, Snohomish
36 River chinook salmon exceeded escapement goals; returns to the Skagit River were very close to
37 escapement goals, and returns to the Stillaguamish, were the largest in seven years. These
38 increased returns can be attributed to recent reductions in harvest in Canadian and U.S. fisheries.
39

40 Habitat throughout the range of Puget Sound chinook salmon has been blocked or degraded. In
41 general, upper tributaries have been damaged by forest practices and lower tributaries and
42 mainstem rivers have been damaged by agriculture, urbanization, or both. Dikes constructed for
43 flood control, water diversions, dams, destruction and modification of freshwater and estuarine
44 wetlands, and sedimentation caused by forest practices and urban development threaten Puget
45 Sound chinook salmon (WDF *et al.* 1993). All of these habitat changes have reduced levels of
46 escapement in Puget Sound chinook salmon.
47

1 **4.9.2 Lower Columbia River chinook salmon**

2
3 **4.9.2.1 Species description and distribution**

4
5 Lower Columbia River chinook salmon includes all native populations from the mouth of the
6 Columbia River to the crest of the Cascade Range, excluding populations above Willamette
7 Falls. The Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river
8 systems on the Washington side, and the lower Willamette and Sandy Rivers are foremost on the
9 Oregon side. The eastern boundary for this species occurs at Celilo Falls, which corresponds to
10 the edge of the drier Columbia Basin Ecosystem and historically may have been a barrier to
11 salmon migration at certain times of the year.

12
13 Fall-run fish form the majority of these chinook salmon, whose stocks tend to migrate north once
14 they reach the ocean. This is supported by recoveries of coded-wire-tags for lower Columbia
15 River chinook salmon, which tend to be recovered off the British Columbia and Washington
16 coasts, with a small proportion recovered in Alaskan waters.

17
18 Stream-type spring-run chinook salmon found in the Klickitat River are not included in this
19 species (they are considered Mid-Columbia River spring-run chinook salmon) or the introduced
20 Carson spring-chinook salmon strain. “Tule” fall chinook salmon in the Wind and Little White
21 Salmon Rivers are included in this species, but not introduced “upriver bright” fall-chinook
22 salmon populations in the Wind, White Salmon, and Klickitat Rivers.

23
24 There is some question whether any natural-origin spring chinook salmon remain in this species.
25 Fourteen hatchery stocks were included in the species; one was considered essential for recovery
26 (Cowlitz River spring chinook) but was not listed.

27
28 **4.9.2.2 Listing status**

29
30 Lower Columbia River chinook salmon were listed as threatened under the ESA in 1999.
31 Critical habitat has not been designated for these salmon.

32
33 **4.9.2.3 Population status and trends**

34
35 There are no reliable estimates of the historic abundance of Lower Columbia River chinook
36 salmon, but experts generally agree that naturally-spawning populations of this species have
37 declined dramatically over the last century. By the 1990s, spawning runs of this species have
38 been sustained by hatchery production. For example, between 1991 and 1995, estimated
39 escapements of this species have included 29,000 natural spawners and 37,000 hatchery
40 spawners and about 68% of the natural spawners were first-generation hatchery strays (PFMC
41 1996).

42
43 **4.9.2.4 Impacts of human activity on this species**

44
45 All basins in the range of Lower Columbia River chinook salmon have been adversely affected
46 by habitat degradation. Major habitat problems are related primarily to blockages, forest
47 practices, urbanization in the Portland and Vancouver areas, and agriculture in flood plains and
48 low-gradient tributaries. Substantial chinook salmon spawning habitat has been blocked (or
49 passage substantially impaired) in the Cowlitz (Mayfield Dam 1963, Rkm 84), Lewis (Merwin

1 Dam 1931, RKm 31), Clackamas (North Fork Dam 1958, RKm 50), Hood (Powerdale Dam
2 1929, RKm 7), and Sandy (Marmot Dam 1912, RKm 48; Bull Run River dams in the early
3 1900s) rivers (WDF et al. 1993, Kostow 1995).
4

5 Hatchery programs in the lower Columbia River began in the 1870s, expanded rapidly, and have
6 continued throughout this century. Although the majority of the stocks have come from within
7 the range of this species, over 200 million fish from outside the range of this species have been
8 released since 1930. A particular concern noted at the time of listing related to the straying by
9 Rogue River fall-run chinook salmon, which are released into the lower Columbia River to
10 augment harvest opportunities. The release strategy has since been modified to minimize
11 straying, but it is too early to assess the effect of the change. Available evidence indicates a
12 pervasive influence of hatchery fish on most natural populations throughout the range of this
13 species, including both spring- and fall-run populations (Howell et al. 1985, Marshall et al.
14 1995). In addition, the exchange of eggs between hatcheries in this species has led to the
15 extensive genetic homogenization of hatchery stocks (Utter et al. 1989).
16

17 **4.9.3 Upper Columbia River spring chinook salmon**

18 **4.9.3.1 Species description and distribution**

19 The Upper Columbia River spring chinook salmon include stream-type chinook salmon that
20 inhabit tributaries upstream from the Yakima River to Chief Joseph Dam. They currently spawn
21 in only three river basins above Rock Island Dam: the Wenatchee, Entiat, and Methow Rivers.
22 Several hatchery populations are also listed including those from the Chiwawa, Methow, Twisp,
23 Chewuch, and White rivers, and Nason Creek.
24
25

26
27 Adults of this species return to the Wenatchee River from late March to early May, and from late
28 March to June in the Entiat and Methow rivers. Most adults return after spending two years in
29 the ocean, while 20%-40% return after three years at sea. Like the Snake River spring/summer
30 chinook, Upper Columbia River spring chinook are subject to very little ocean harvest.
31

32 **4.9.3.2 Listing status**

33
34 Upper Columbia River chinook salmon were listed as endangered under the ESA in 1999.
35 Critical habitat has not been designated for these salmon.
36

37 **4.9.3.3 Population status and trends**

38
39 There are no historical estimates of the size of Upper Columbia chinook salmon populations.
40 Adult escapements of this species throughout its range continue to be critically low and redd
41 counts are still declining severely.
42

43 Upper Columbia River chinook salmon have been reduced to small populations in three
44 watersheds. Population viability analyses for this species (using the Dennis Model) suggest that
45 these chinook salmon face a significant risk of extinction: a 75 to 100 percent probability of
46 extinction within 100 years (given return rates for 1980 to present).
47

48 **4.9.3.4 Impacts of human activity on this species**

49

1 Historical artificial propagation efforts have had a significant impact on spring-run populations
2 of this chinook salmon. Extensive introductions of spring-run chinook salmon from outside this
3 species and egg transfers within the species have affected the genetics of Upper Columbia River
4 chinook salmon. In addition, despite their small population size and high risk of extinction,
5 Upper Columbia River chinook salmon are still taken in fisheries; although harvest rates for this
6 species are estimated to be less than 10 percent (ODFW and WDFW 1998).
7

8 **4.9.4 Upper Willamette River Chinook Salmon**

9

10 **4.9.4.1 Species description and distribution**

11

12 Upper Willamette River chinook salmon occupy the Willamette River and tributaries upstream of
13 Willamette Falls. Historically, access above Willamette Falls was restricted to the spring when
14 flows were high. In autumn, low flows prevented fish from ascending past the falls. The Upper
15 Willamette spring chinook are one of the most genetically distinct chinook groups in the
16 Columbia River Basin. Fall chinook salmon spawn in the Upper Willamette but are not
17 considered part of the species because they are not native. None of the hatchery populations in
18 the Willamette River were listed although five spring-run hatchery stocks were included in the
19 species.
20

21 The ocean distribution of Upper Willamette River chinook salmon is consistent with an ocean-
22 type life history with the majority of chinook being caught off the coasts of British Columbia and
23 Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook
24 stocks in the Columbia Basin with freshwater entry beginning in February. Historically,
25 spawning occurred between mid-July and late October. However, the current spawn timing of
26 hatchery and wild chinook in September and early October has probably been changed through
27 introgression with hatchery salmon.
28

29 **4.9.4.2 Listing status**

30

31 Upper Willamette River chinook salmon were listed as threatened under the ESA in 1999.
32 Critical habitat has not been designated for these salmon.
33

34 **4.9.4.3 Population status and trends**

35

36 Populations of naturally-produced Upper Willamette River spring chinook are substantially
37 smaller than they were historically, when escapement levels may have been as high as 200,000
38 fish per year. The Willamette River's ability to produce salmon has been reduced by extensive
39 dam construction and habitat degradation. In response, chinook salmon populations in the
40 Willamette River have declined. From 1946 to 1950, geometric mean counts of spring chinook
41 was 31,000 fish, primarily naturally-produced salmon (Myers *et al.* 1998). From 1995 to 1999,
42 geometric mean counts of spring chinook salmon was 27,800 fish, primarily hatchery-produced
43 salmon.
44

45 **4.9.4.4 Impacts of human activity on this species**

46

47 Historically, five rivers produced spring chinook in the Willamette River basin, including the
48 Clackamas, North and South Santiam Rivers, McKenzie, and the Middle Fork Willamette.
49 However, between 1952-1968 dams were built on all of the major rivers in the basin that

1 supported spring chinook, preventing these salmon from reaching more than half of the most
2 important spawning and rearing habitat in the Willamette River basin. Dams on the South Fork
3 Santiam and Middle Fork Willamette eliminated wild spring chinook in those systems (ODFW
4 1997). Populations in several smaller tributaries that also used to support spring chinook are
5 believed to be extinct (Nicholas 1995).

6
7 Mitigation hatcheries were built to offset the effects of the dams in the Willamette River basins.
8 As a result, 85 to 95% of the chinook salmon in the basin originated in a hatchery.
9

10 **4.9.5 Snake River Spring/summer Chinook Salmon**

11 **4.9.5.1 Species description and distribution**

12
13 Snake River spring/summer chinook salmon are primarily limited to the Salmon, Grande Ronde,
14 Imnaha, and Tucannon Rivers in the Snake River basin. Most adult Snake River spring/summer
15 chinook salmon enter these rivers to spawn from May through September. Juvenile Snake River
16 spring/summer chinook salmon emerge from spawning gravels from February through June.
17 After rearing in nursery streams for about one year, smolts begin migrating seaward in April and
18 May. After reaching the mouth of the Columbia River, spring/summer chinook salmon probably
19 inhabit nearshore areas before migrating to the northeast Pacific Ocean where they will remain
20 for two to three years.
21

22 **4.9.5.2 Listing status**

23
24 Snake River spring-summer chinook salmon were listed as endangered under the ESA in 1992.
25 Critical habitat for these salmon was designated in 1993. This critical habitat encompasses the
26 waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the
27 Columbia River that are or were accessible to listed Snake River salmon (except reaches above
28 impassable natural falls, and Dworshak and Hells Canyon Dams) and is well beyond the area that
29 is likely to be directly or indirectly affected by the proposed action.
30
31

32 **4.9.5.3 Population status and trends**

33
34 In the late 1800s, the population of wild, adult Snake River spring/summer chinook salmon was
35 estimated at more than 1.5 million adults. By the 1950s, the population had declined to an
36 estimated 125,000 adults and continued to decline through the 1970s. Returns were variable
37 through the 1980s, but declined further in the 1990s. Record low returns were observed in 1994
38 and 1995. Dam counts were modestly higher from 1996–1998, but declined in 1999.
39

40 In 2000, 134,000 Snake River spring chinook salmon were expected to return to the Snake River,
41 which would be the highest return in over 30 years. Only a small portion of these returning
42 salmon (5,800) are expected to be natural-origin spring chinook destined for the Snake River.
43 Expected returns to the Tucannon River (500 listed hatchery and wild fish), Imnaha River (800
44 wild and 1,600 listed hatchery fish), and Sawtooth Hatchery (368 listed hatchery fish) all
45 represent substantial increases over past years.
46

47 In 2000, 33,300 Snake River summer chinook salmon were expected to return to the Snake River,
48 which is the second highest return in over 30 years, but only a small portion of these animals
49 (2,000) are expected to be natural-origin salmon. The return of natural-origin fish is slightly more

1 than half of the five-year average (3,466).

2
3 In 1999, NMFS conducted an analysis referred to as Cumulative Risk Initiative, which estimated
4 the Snake River spring/summer chinook salmon's probability of extinction for 10- and 100-year
5 periods (NWFSC 1999). For some of the index stocks of this species, the risk analysis estimated
6 the Marsh River subpopulation had a 90 percent probability of extinction within 100 years; the
7 Imnaha River subpopulation had a 74 percent probability of extinction within 100 years; the Bear
8 Creek and Sulphur River subpopulations had 50 percent probabilities of extinction; and the
9 remaining three subpopulations had extinction probabilities that ranged between 30 and 40
10 percent.

11 **4.9.5.4 Impacts of human activity on this species**

12
13
14 Recent analyses conducted through the Plan for Analyzing and Testing Hypotheses (called
15 PATH) considered this species' likelihood of surviving and recovering given several future
16 management options for the Columbia River hydrosystem and other causes of mortality. That
17 analysis indicated that Snake River spring/summer chinook salmon had a good chance of
18 surviving, but full recovery was unlikely except under a very limited range of assumptions
19 (unless drawdowns were implemented for at least the four lower Snake River dams operated by
20 the U.S. Army Corps of Engineers). If the four, lower Snake River dams were drawn down,
21 Snake River spring/summer chinook salmon had a high likelihood of surviving and recovering in
22 the wild.

23
24 The Northwest Fisheries Science Center has recently considered the extinction risk for Snake
25 River spring/summer chinook as part of their Cumulative Risk Initiative, which was based on
26 seven "index" populations of Snake River spring/summer chinook salmon (out of a total of 35 to
27 40 populations). Two populations have a 10 percent risk of declining to one individual in ten
28 years, four populations have 56 to 88 percent probability of declining to one individual in 100
29 years that range between 56 and 88 percent, and the remaining three populations have more than
30 30 percent probability of declining to this level within 100 years if nothing changes.

31 **4.9.6 Snake River fall chinook salmon**

32 **4.9.6.1 Species description and distribution**

33
34
35
36 The present range of spawning and rearing habitat for naturally-spawned Snake River fall
37 chinook salmon is primarily limited to the Snake River below Hells Canyon Dam and the lower
38 reaches of the Clearwater, Grand Ronde, Salmon, and Tucannon Rivers.

39
40 Although Snake River fall chinook have been recovered in North Pacific Fishery Management
41 Council groundfish fisheries, several upper Columbia River fall chinook (known as upriver
42 brights) have been recovered in GOA groundfish fisheries. The presence of upriver brights in
43 Gulf of Alaska fisheries suggests that Snake River fall chinook probably occur in North Pacific
44 Fishery Management Council groundfish fisheries.

45 **4.9.6.2 Life history information**

46
47 Unlike many other listed salmon, Snake River fall chinook is probably represented by only a
48 single population that spawns in parts of the mainstem of the river and lower reaches of
49

1 tributaries. Adult Snake River fall chinook salmon enter the Columbia River in July and migrate
2 into the Snake River from August through October. Fall chinook salmon generally spawn from
3 October through November and fry emerge from March through April. Downstream migration
4 generally begins within several weeks of emergence (Becker 1970, Allen and Meekin 1973), and
5 juveniles rear in backwaters and shallow water areas through mid-summer prior to smolting and
6 migrating to the ocean—thus they exhibit an “ocean” type juvenile history. Once in the ocean,
7 they spend one to four years (usually three) before beginning their spawning migration. Fall
8 returns in the Snake River system are typically dominated by four-year-old fish.
9

10 **4.9.6.3 Listing status**

11
12 Snake River fall chinook salmon were listed as endangered under the ESA in 1992. Critical
13 habitat for these salmon was designated in 1993. This critical habitat encompasses the waters,
14 waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the
15 Columbia River that are or were accessible to listed Snake River salmon (except reaches above
16 impassable natural falls, and Dworshak and Hells Canyon Dams) and is well beyond the area that
17 is likely to be directly or indirectly affected by the proposed action.
18

19 **4.9.6.4 Population status and trends**

20
21 There are no reliable estimates of historical population sizes of Snake River fall chinook salmon.
22 The mean number of adult Snake River fall chinook salmon was estimated to have declined from
23 72,000 in the 1930s and 1940s to 29,000 during the 1950s. In spite of these declines, the Snake
24 River was the most important area natural production of fall chinook in the Columbia River basin
25 through the 1950s. The number of adults counted at the uppermost Snake River mainstem dams
26 averaged 12,720 total spawners from 1964 to 1968, 3,416 spawners from 1969 to 1974, and 610
27 spawners from 1975 to 1980 (Waples, *et al.* 1991). Counts of adult fish of natural-origin
28 continued to decline through the 1980s when they reached a low of 78 individuals in 1990. Since
29 1990, returns of natural-origin fish to Lower Granite Dam have been variable, but increasing.
30 They reached a high of 797 in 1997 only to decline to 306 in 1998.
31

32 The Lyons Ferry Hatchery population of Snake River fall chinook, which was included in this
33 species’ listing, helps buffer this species from natural declines. In recent years, several hundred
34 adult fall chinook salmon have returned to Lyons Ferry Hatchery and smolt from the 1995 brood-
35 year were outplanted to accelerate rebuilding this species. Nevertheless, supplementation will not
36 substitute for habitat restoration to recover this species because of this species’ ecology.
37

38 **4.9.6.5 Impacts of human activity on the species**

39
40 Irrigation and hydroelectric projects on the Snake River probably had a greater impact on fall
41 chinook than any other species of salmon, because fall chinook spawn in the mainstem of the
42 river. Recent analyses conducted through the Plan for Analyzing and Testing Hypotheses
43 considered the prospects for survival and recovery given several future management options for
44 the hydro system and other mortality sectors (Peters et al. 1999). That analysis indicated that the
45 prospects of survival for Snake River fall chinook were good, but that full recovery was
46 relatively unlikely except under a very limited range of assumptions, or unless draw down was
47 implemented for at least the four lower Snake River dams operated by the U.S. Army Corps of
48 Engineers. Consideration of the draw down options led to a high likelihood that both survival
49 and recovery objectives could be achieved.

1 The Northwest Fisheries Science Center recently considered the extinction risk for Snake River
2 fall chinook as part of their Cumulative Risk Initiative. The results of these analyses indicate
3 that the probability of extinction for Snake River fall chinook over the next ten years is near zero
4 while the risk of extinction over 100 years is between 6–17% (depending on whether 1980 is
5 included in the baseline analysis).

6 7 **4.10 Snake River Sockeye Salmon**

8 9 **4.10.1 Species description and distribution**

10
11 Sockeye salmon occur in the North Pacific and Arctic oceans and associated freshwater systems. This
12 species ranges south as far as the Klamath River in California and northern Hokkaido in Japan, to as far
13 north as far as Bathurst Inlet in the Canadian Arctic and the Anadyr River in Siberia. Sockeye salmon
14 were an important food source for aboriginal people who either ate them fresh or dried them for winter
15 use. Today sockeye salmon remain an important mainstay of many subsistence users and support one of
16 the most important commercial and recreational fisheries on the Pacific coast of North America.

17
18 Sockeye salmon can be distinguished from chinook, coho, and pink salmon by the lack of large, black
19 spots and from chum salmon by the number and shape of gill rakers on the first gill arch. Sockeye
20 salmon have 28 to 40 long, slender, rough or serrated closely set rakers on the first arch. Chum salmon
21 have 19 to 26 short, stout, smooth rakers.

22
23 Immature and pre-spawning sockeye salmon are elongate, fusiform, and somewhat laterally compressed.
24 They are metallic green blue on the back and top of the head, iridescent silver on the sides, and white or
25 silvery on the belly. Some fine black speckling may occur on the back, but large spots are absent.
26 Juveniles, while in fresh water, have the same general coloration as immature sockeye salmon in the
27 ocean, but are less iridescent. Juveniles also have dark, oval parr marks on their sides. These parr marks
28 are short-less than the diameter of the eye-and rarely extend below the lateral line. Breeding males
29 develop a humped back and elongated, hooked jaws filled with sharp caniniform teeth. Both sexes turn
30 brilliant to dark red on the back and sides, pale to olive-green on the head and upper jaw, and white on
31 the lower jaw.

32
33 Snake River sockeye salmon is one of three stock of sockeye salmon that remain in the Columbia River
34 basin. This species includes sockeye populations from the Snake River Basin, Idaho, although the only
35 remaining populations of this species occur in the Stanley River Basin of Idaho.

36 37 **4.10.2 Life history information**

38
39 Adult Snake River sockeye salmon enter the Columbia River during June and July. Their arrival at
40 Redfish Lake, which now supports the only remaining run of Snake River sockeye salmon, peaks in
41 August; spawning occurs primarily in October. Eggs hatch in the spring between 80 and 140 days after
42 spawning. Fry remain in the gravel for three to five weeks, emerge from April through May and move
43 immediately into the lake. Once there, juvenile sockeye salmon feed on plankton for one to three years
44 before they migrate to the ocean. Migrants leave Redfish Lake from late April through May and smolts
45 migrate almost 900 miles to the Pacific Ocean.

46
47 Smolts pass Lower Granite Dam (the first dam on the Snake River downstream from the Salmon River)
48 from late April to July with peak passage from May to late June (Fish Passage Center 1992). Once in the
49 ocean, Snake River sockeye salmon smolts remain inshore or within the Columbia River influence during

1 the early summer. Later, they migrate through the northeast Pacific Ocean where they remain for two to
2 three years (Hart 1973, Hart and Dell 1986). Snake River sockeye salmon usually begin the spawning
3 migration in their fourth or fifth year of life.
4

5 **4.10.3 Listing status**

6
7 Snake River sockeye salmon were listed as endangered under the ESA in 1991. Critical habitat for these
8 salmon was designated in 1993. This critical habitat encompasses the waters, waterway bottoms, and
9 adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were
10 accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak
11 and Hells Canyon Dams) and is well beyond the area that is likely to be affected by the proposed action.
12

13 **4.10.4 Population status and trends**

14
15 Historically, the largest numbers of Snake River sockeye salmon returned to headwaters of the Payette
16 River, where 75,000 were taken in one year by a single fishing operation on Big Payette Lake (Bevan et
17 al. 1994). During the early 1880s, returns of Snake River sockeye salmon to the headwaters of the
18 Grande Ronde River in Oregon were estimated between 24,000 and 30,000 at a minimum. During the
19 1950s and 1960s, adult returns to Redfish Lake numbered more than 4,000 fish. By 1985, the number of
20 adults arriving at Redfish Lake, Idaho, had fallen below 20 animals. Between 1990 and 1998, only 16
21 “wild” Snake River sockeye salmon returned to Redfish Lake or the nearby Sawtooth Hatchery
22 (including one in 1998 and none in 1999).
23

24 Since 1991, all returning adults Snake River sockeye salmon have been spawned in a hatchery to prevent
25 the species’ extinction. The first adults produced by this program (from the 1991 returns) were released
26 into Redfish Lake to spawn in 1993 and their progeny were expected to outmigrate in the spring of 1995.
27 Sixteen sockeye were observed at Lower Granite Dam in 1999, seven of which return to the Sawtooth
28 Hatchery weir. By Aug. 8 of 2000, 149 four-year-old sockeye adults had made the 900-mile journey
29 from the ocean to Redfish Lake or Sawtooth Hatchery. Most are products of either sockeye adults
30 produced in the hatchery program and released to spawn in 1996 or year-old smolts released near the
31 hatchery or in Redfish Creek. All are progeny of eight, lone returning "wild" sockeye salmon that had
32 been taken into the program as broodstock in 1993.
33

34 Given the extremely low sockeye salmon population size, this species’ likelihood of surviving in the wild
35 remains fairly low. Snake River sockeye will remain below the threshold escapement level of 150 fish
36 (which applies only to naturally-produced spawners) until natural production is sufficiently re-
37 established. This species’ likelihood of recovering in the wild (which only applies to spawners at least
38 two generations removed from captive broodstock) is even less certain.
39

40 **4.10.5 Impacts of human activity on the species**

41
42 The following discussion briefly summarizes the combined effect of the natural phenomena and human
43 activities, including hydropower systems, harvests, hatcheries, and habitat degradation, on the status of
44 Snake River sockeye salmon.
45

46 **4.10.5.1 Hydropower**

47
48 The network of dams, reservoirs, and diversions that comprise the hydropower system in the
49 Columbia River and Snake River basins has substantially reduced or eliminated populations of

1 sockeye salmon. The hydropower system has increased water temperatures, changed the
2 structure of freshwater fish communities, and depleted flows necessary for salmon migration,
3 spawning, rearing by flushing sediment from spawning gravels, altering gravel recruitment, and
4 eliminating the transport of large woody debris. Physical features of dams, such as turbines and
5 sluiceways, have increased the mortality of both adult and juvenile salmon in the Columbia River
6 basin. In some cases, the dams block access to spawning and rearing habitat and have a direct
7 effect on populations of sockeye salmon. In other cases, the dams have indirect effects on these
8 salmon by increasing the number of adults and juveniles that are killed during downstream and
9 upstream migrations; changing natural flow regimes; de-watering or reduce flows to downstream
10 areas; and disrupting the movement of gravel necessary to maintain spawning sites.

11
12 Reservoirs associated with the hydropower system in the Columbia River Basin create ecological
13 conditions that are ideal for native, predatory fish and non-native fish species. The result has
14 been increased predation of juvenile sockeye salmon. Predators such as northern pikeminnow
15 (*Ptychocheilus oregonensis*), walleye (*Stizostedion vitreum*), smallmouth bass (*Micropterus*
16 *dolomieu*), and channel catfish (*Ictalurus punctatus*) consume between 9 and 19 percent of the
17 juvenile salmon entering reservoirs, with northern pikeminnow accounting for about 78 percent
18 of this loss.

19 20 **4.10.5.2 Harvests**

21
22 Many stock of sockeye salmon were threatened by fishing pressure before their habitat was
23 degraded. Even after watersheds of western United States, were destroyed or degraded many
24 populations of sockeye salmon were still being exploited at unsustainable rates. As a result of
25 these threats, many sockeye salmon runs became extinct.

26
27 The State of Idaho conducts a fishery for kokanee salmon in Redfish Lake, the last known
28 spawning area for sockeye salmon, from January through August. Pettit Lake and Alturas Lakes
29 are also open to kokanee fishing throughout the year, despite stocking programs for endangered
30 sockeye salmon in those lakes. Between 1995 and 1998, about 59, listed, sockeye salmon have
31 been taken in these fisheries. These lakes are also stocked with trout to support a year-around,
32 recreational fishery. The State of Idaho has applied for a permit to release rainbow trout into
33 Redfish Lake to support a put-and-take fishery in the lake, but the permit has not been
34 authorized.

35
36 In addition, Snake River sockeye salmon are captured in winter-, spring-, and summer-season
37 fisheries in the Columbia River Basin conducted by the Columbia River treaty tribes (the Nez
38 Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated
39 Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of
40 the Yakama Indian Nation). The tribes generally manage their fisheries to prevent harvest rates
41 on upriver summer chinook stocks and sockeye from exceeding 5%, but actual harvest rates on
42 Snake River summer chinook and Snake River sockeye have averaged 1.5% (range 0.4 - 3.1) and
43 4.3% (range 2.6 - 6.0) since 1990.

44 45 **4.10.5.3 Hatcheries**

46
47 About 80 percent of the annual adult salmon that return to the Columbia River Basin to spawn
48 came from a hatchery. Nearly all of the 100 or more hatcheries in the Columbia River basin
49 were constructed to compensate for the loss of fish and fish habitat that was caused by the

1 hydropower system; together they produce about 150 million salmon each year.

2
3 Hatcheries benefit native salmon by conserving natural populations in areas where habitat
4 conditions can no longer support natural spawning or where the numbers of returning adults are
5 so low that a population has an immediate risk of extinction. At the same time, hatcheries hurt
6 natural populations of salmon through interbreeding between hatchery and wild salmon (which
7 can adversely affect the health of wild salmon populations), predation by larger hatchery salmon
8 on smaller wild salmon, competition between hatchery and wild salmon for food and space,
9 disease transmission, and by supporting mixed-stock fisheries that target large populations of
10 hatchery salmon may overharvest smaller populations of wild salmon.

11 **4.10.5.4 Habitat**

12
13
14 Forestry, agriculture, mining, urbanization, grazing, flood control, dredging, water pollution,
15 water withdrawals, hydropower, road construction, and recreational activities have destroyed and
16 degraded aquatic and riparian ecosystems throughout the Columbia and Snake River basins.
17 Examples of habitats that have been destroyed in the region include riparian and aquatic
18 ecosystems (in 1988, about 95% of streams surveyed in Oregon has been moderately or severely
19 degraded by excessive sedimentation, high water temperatures, bank instability and other
20 problems related to logging and removal of large woody debris; FEMAT 1993), wetlands
21 (reduced by 30 percent in Washington and Oregon; NMFS 1998), and forests, which experienced
22 significant changes in structure and composition after 50 years of even-age timber management.
23 In addition, water throughout large portions of the Pacific Northwest has been diverted for
24 agriculture, flood control, and domestic uses. Combined with the effects of the hydropower
25 system in the Columbia River basin, these habitat losses have had devastating effects on
26 populations of sockeye salmon in Pacific Northwest.

27
28 Federal, state, and local governments in the Columbia River basin are undertaking several efforts
29 to slow or reverse the decline of sockeye salmon populations that include the Northwest Forest
30 Plan, PACFISH, Lower Columbia River National Estuary Program, Lower Columbia Steelhead
31 Conservation Initiative, Oregon Plan for Salmon and Watersheds, Washington Wild Stock
32 Restoration Initiative, and Washington Wild Salmonid Policy.

33 **4.10.5.5 Natural Phenomena**

34
35
36 Natural variations in freshwater and marine environments have substantial effects on the
37 abundance of salmon populations. Of the various natural phenomena that affect most populations
38 of Pacific salmon, changes in ocean productivity are generally considered most important.
39 Recent evidence suggests that the survival of Pacific salmon in the marine environment
40 fluctuates in response to long-term cycles of climatic conditions and ocean productivity (20–30
41 years); these fluctuations cause salmon survival to be either above-average or below-average.
42 These long-term, climatic fluctuations have been referred to as the Pacific Decadal Oscillation.
43 For many years, ocean conditions and resulting productivity appear to have produced below-
44 average marine survival rates for Pacific salmon, which has reduced the size of salmon
45 populations throughout Pacific Northwest.

46
47 At the same time, the long-term survival of Pacific salmon depends on the productivity of
48 freshwater ecosystems, which determines the number of salmon that enter the ocean. During the
49 early 1990s, freshwater ecosystems throughout the Pacific coast were affected by a series of very

1 dry years, which adversely affected the survival of adult and juvenile salmon in those areas.
2 More recently, severe flooding throughout the Pacific Northwest has reduced the spawning
3 success of salmon populations in the region.
4

5 Like other species of salmon, sockeye salmon are exposed to high rates of natural predation,
6 particularly during freshwater rearing and migration stages. Ocean predation probably
7 contributes to significant natural mortality, although the levels of predation are largely unknown.
8 In general, sockeye salmon are prey for pelagic fishes, birds, and marine mammals, including
9 harbor seals, sea lions, and killer whales. There have been recent concerns that increasing size of
10 tern, seal, and sea lion populations in the Pacific Northwest has dramatically reduced the survival
11 of adult and juvenile salmon in the Columbia River estuary.
12

13 Recent analyses conducted through the Plan for Analyzing and Testing Hypotheses considered
14 the prospects for survival and recovery given several future management options for the hydro
15 system and other mortality sectors (Marmorek, et al. 1998, Peters, et al. 1999). That analysis
16 indicated that the prospects of survival for Snake River sockeye were not optimistic and full
17 recovery was relatively unlikely except under a very limited range of assumptions, or unless
18 draw down was implemented for at least the four lower Snake River dams operated by the U.S.
19 Army Corps of Engineers. Consideration of the draw down options led to a high likelihood that
20 both survival and recovery objectives could be achieved.
21

22 **4.11 Steelhead**

23 Unlike Pacific salmon, steelhead are capable of spawning more than once before death (iteroparity).
24 However, steelhead rarely spawn more than twice before dying; most that do so are females (August 9,
25 1996, 61 FR 41542). Biologically, steelhead can be divided into two basic run-types: the stream-maturing
26 type, or summer steelhead, enters fresh water in a sexually immature condition and requires several
27 months in freshwater to mature and spawn and the ocean-maturing type, or winter steelhead, enters fresh
28 water with well-developed gonads and spawns shortly after river entry (August 9, 1996, 61 FR 41542;
29 Burgner et al. 1992). Variations in migration timing exist between populations. Some river basins have
30 both summer and winter steelhead, while others only have one run-type.
31

32
33 Five threatened or endangered species of steelhead are known to occur in the action area for this
34 consultation. Because of similarities in their life history and the threats to their survival and recovery in
35 the wild, these issues will be addressed for all six of these species below. Specific information on their
36 Listing Status, Population Status and Trends, and Impacts that are not shared will be discussed further for
37 each of these six species.
38

39 **General life history information**

40
41 Summer steelhead enter freshwater between May and October in the Pacific Northwest (Busby et al.
42 1996). They require cool, deep holding pools during summer and fall, prior to spawning. They migrate
43 inland toward spawning areas, overwinter in the larger rivers, resume migration in early spring to natal
44 streams, and then spawn (Meehan and Bjornn 1991).
45

46 Winter steelhead enter freshwater between November and April in the Pacific Northwest (Busby et al.
47 1996), migrate to spawning areas, and then spawn in late winter or spring. Some adults, however, do not
48 enter coastal streams until spring, just before spawning. Steelhead typically spawn between December
49 and June (Bell 1991), and the timing of spawning overlaps between populations regardless of run type

1 (Busby et al. 1996).

2
3 Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity.
4 Intermittent streams may also be used for spawning (Barnhart 1986; Everest 1973). Depending on water
5 temperature, steelhead eggs may incubate for 1.5 to 4 months (August 9, 1996, 61 FR 41542) before
6 hatching. Juveniles rear in fresh water from one to four years, then migrate to the ocean as smolts
7 (August 9, 1996, 61 FR 41542). Winter steelhead populations generally smolt after two years in fresh
8 water (Busby et al. 1996).

9
10 Steelhead typically reside in marine waters for two or three years before migrating to natal their streams
11 to spawn as four- or five-year olds (August 9, 1996, 61 FR 41542). Populations in Oregon and California
12 have higher frequencies of age-1-ocean steelhead than populations to the north, but age-2-ocean
13 steelhead generally remain dominant (Busby et al. 1996). Age structure appears to be similar to other
14 west coast steelhead, dominated by four-year-old spawners (Busby et al. 1996).

15 16 **4.11.1 Upper Columbia River Steelhead**

17 18 **4.11.1.1 Species description and distribution**

19
20 Upper Columbia River steelhead occupy the Columbia River Basin upstream from the Yakima
21 River, Washington, to the border between the United States and Canada. This area includes the
22 Wenatchee, Entiat, and Okanogan Rivers. All upper Columbia River steelhead are summer
23 steelhead. Steelhead primarily use streams of this region that drain the northern Cascade
24 Mountains of Washington State. This species includes hatchery populations of summer
25 steelhead from the Wells Hatchery because it probably retains the genetic resources of steelhead
26 populations that once occurred above the Grand Coulee Dam. This species does not include the
27 Skamania Hatchery stock because of its non-native genetic heritage.

28 29 **4.11.1.2 Listing status**

30
31 Upper Columbia River steelhead were listed as endangered under the ESA in 1997. Critical
32 habitat for these salmon was designated in 2000. This critical habitat includes all river reaches
33 accessible to listed steelhead in Columbia River tributaries upstream of the Yakima River,
34 Washington, and downstream of Chief Joseph Dam. This critical habitat is well beyond the area
35 that is likely to be directly or indirectly affected by the proposed action.

36 37 **4.11.1.3 Population status and trends**

38
39 Returns of Upper Columbia River natural-origin steelhead to Priest Rapids dam have declined
40 from a 4-year average of 2,900 (beginning in 1986-1987) to 900 (present) although escapements
41 appear to have stabilized at a range of 800-900, over the past six years. Hatchery populations of
42 Upper Columbia River steelhead are included in the species and are also listed as endangered.
43 The hatchery component is relatively abundant and usually, exceeds hatchery supplementation
44 program needs by a substantial margin.

45
46 The naturally spawning population of Upper Columbia River steelhead has been augmented for a
47 number of years by stray hatchery fish that have spawned naturally. Replacement ratios for
48 naturally spawning fish (natural-origin and hatchery strays) are quite low, on the order of 0.3.
49 This very low return rate suggests that the productivity of the river basin is so low hatchery

1 strays have been supporting the population.
2

3 **4.11.1.4 Impacts of human activity on this species** 4

5 When this species was listed, the Biological Review Team that reviewed the status of this species
6 concluded that Upper Columbia steelhead are presently in danger of extinction. While total
7 abundance of populations within this Evolutionary Significant Unit (ESU) has been relatively
8 stable or increasing, this appears to be occurring only because of major hatchery supplementation
9 programs. Estimates of the proportion of hatchery fish in spawning escapement are 65%
10 (Wenatchee River) and 81% (Methow and Okanogan Rivers). Their major concern for this
11 species was the clear failure of natural stocks to replace themselves. They were also concerned
12 about problems of genetic homogenization due to hatchery supplementation within the species
13 and about the apparent high harvest rates on steelhead smolts in rainbow trout fisheries and the
14 degradation of freshwater habitats within the region, especially the effects of grazing, irrigation
15 diversions, and hydroelectric dams.
16

17 **4.11.2 Middle Columbia River Steelhead** 18

19 **4.11.2.1 Species description and distribution** 20

21 Middle Columbia steelhead occupy the Columbia River Basin from Mosier Creek, Oregon,
22 upstream to the Yakima River, Washington, inclusive (61 FR 41541; August 9, 1996). Steelhead
23 from the Snake River Basin (described elsewhere) are excluded. This species includes the only
24 populations of inland winter steelhead in the United States, in the Klickitat River and Fifteenmile
25 Creek (Busby et al. 1996). Two hatchery populations are considered part of this species, the
26 Deschutes River stock (ODFW stock 66) and the Umatilla River stock (ODFW stock number
27 91); listing for neither of these stocks was considered warranted.
28

29 Most Middle Columbia River steelhead smolt at 2 years and spend 1 to 2 years in salt water (i.e.,
30 1-ocean and 2-ocean fish, respectively) prior to re-entering fresh water, where they may remain
31 up to a year prior to spawning (Howell *et al.*, 1985). Within this species, the Klickitat River is
32 unusual in that it produces both summer and winter steelhead, and the summer steelhead are
33 dominated by 2-ocean steelhead, whereas most other rivers in this region produce about equal
34 numbers of both 1-and 2-ocean steelhead.
35

36 **4.11.2.2 Listing status** 37

38 Middle Columbia River steelhead were listed as endangered under the ESA in 1999. Critical
39 habitat for Middle Columbia River steelhead was designated in 2000 and includes all river
40 reaches accessible to listed steelhead in Columbia River tributaries (except the Snake River)
41 between Mosier Creek in Oregon and the Yakima River in Washington (inclusive). This critical
42 habitat is well beyond the area that is likely to be affected by the proposed action.
43

44 **4.11.2.3 Population status and trends** 45

46 Populations of Middle Columbia River steelhead in the Yakima, Umatilla and Deschutes River
47 basins appear to be increasing. Part of the reason for listing this species as threatened were low
48 returns to the Yakima River, low estimates of winter steelhead abundance in Klickitat River and
49 Fifteenmile Creek, and an overall decline of naturally-producing stocks.

1 **4.11.2.4 Impacts of human activity on this species**
2

3 Middle Columbia River steelhead occupy the intermontane region which includes some of the
4 driest areas of the Pacific Northwest, generally receiving less than 40 cm of rainfall annually.
5 Vegetation is of the shrub-steppe province, reflecting the dry climate and harsh temperature
6 extremes. Because of this habitat, occupied by the species, factors contributing to the decline
7 include agricultural practices, especially grazing, and water diversions and withdrawals. In
8 addition, hydropower development has impacted the species by preventing these steelhead from
9 migrating to habitat above dams, and by killing them in large numbers when they try to migrate
10 through the Columbia River hydroelectric system.
11

12 **4.11.3 Lower Columbia River Steelhead**
13

14 **4.11.3.1 Species description and distribution**
15

16 Lower Columbia River steelhead include naturally-produced steelhead returning to
17 Columbia River tributaries on the Washington side between the Cowlitz and Wind rivers
18 in Washington and on the Oregon side between the Willamette and Hood rivers,
19 inclusive. In the Willamette River, the upstream boundary of this species is at
20 Willamette Falls. This species includes both winter and summer steelhead. Two
21 hatchery populations are included in this species, the Cowlitz Trout Hatchery winter-run
22 stock and the Clackamas River stock (ODFW stock 122) but neither was listed as
23 threatened.
24

25 **4.11.3.2 Listing status**
26

27 Lower Columbia River steelhead were listed as threatened under the ESA in 1998.
28 Critical habitat for Lower Columbia River steelhead was designated in 2000 and includes
29 all river reaches accessible to listed steelhead in Columbia River tributaries between the
30 Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon,
31 inclusive. This critical habitat is well beyond the area that is likely to be directly or
32 indirectly affected by the proposed action.
33

34 **4.11.3.3 Population status and trends**
35

36 There are no historical estimates of this species' abundance. Because of their limited
37 distribution in upper tributaries and urbanization in the lower tributaries (e.g., the lower
38 Willamette, Clackamas, and Sandy Rivers run through Portland or its suburbs), habitat
39 degradation appears to have threatened summer steelhead more than winter steelhead.
40 Steelhead populations in the lower Willamette, Clackamas, and Sandy Rivers appear
41 stable or slightly increasing although sampling error limits the reliability of this trend.
42 Total annual run size data are only available for the Clackamas River (1,300 winter
43 steelhead, 70% hatchery; 3,500 wild summer steelhead).
44

45 **4.11.4 Upper Willamette River steelhead**
46

47 **4.11.4.1 Species description and distribution**
48

49 Upper Willamette River steelhead occupy the Willamette River and its tributaries

1 upstream of Willamette Falls. This is a late-migrating winter group that enters fresh
2 water in March and April (Howell *et al.* 1985). Only the late run was included is the
3 listing of this species, which is the largest remaining population in the Santiam River
4 system.

6 **4.11.4.2 Listing status**

7
8 Upper Willamette River steelhead were listed as threatened under the ESA in 1999.
9 Critical habitat for Willamette River steelhead was designated in 2000 and includes all
10 river reaches accessible to listed steelhead in the Willamette River and its tributaries
11 above Willamette Falls upstream to, and including, the Calapooia River. This critical
12 habitat is well beyond the area that is likely to be affected by the proposed action.
13

14 **4.11.4.3 Population status and trends**

15
16 No estimates of abundance prior to the 1960s are available for this species. Recent run
17 size can be estimated from redd counts, dam counts, and counts at Willamette Falls (late
18 stock). Recent total-basin run size estimates exhibit general declines for winter
19 steelhead. The majority of winter steelhead populations in this basin may not be self-
20 sustaining.

21 **4.11.4.2 Impacts of human activity on this species**

22
23 A major threat to Willamette River steelhead results from artificial production practices.
24 Fishways built at Willamette Falls in 1885 have allowed Skamania-stock summer
25 steelhead and early-migrating winter steelhead of Big Creek stock to enter the range of
26 Upper Willamette River steelhead. The population of summer steelhead is almost
27 entirely maintained by hatchery salmon, although natural-origin, Big Creek-stock winter
28 steelhead occur in the basin (Howell *et al.* 1985). In recent years, releases of winter
29 steelhead are primarily of native stock from the Santiam River system.
30
31

32 **4.11.5 Snake River Basin Steelhead**

33 **4.11.5.1 Species description and distribution**

34
35 Snake River basin steelhead are an inland species that occupy the Snake River basin of
36 southeast Washington, northeast Oregon, and Idaho. The historic spawning range of this
37 species included the Salmon, Pahsimeroi, Lemhi, Selway, Clearwater, Wallowa, Grande
38 Ronde, Imnaha, and Tucannon Rivers.
39
40

41 **4.11.5.2 Life history information**

42
43 Snake River Basin steelhead, like most inland steelhead, are “summer-run” which means
44 they enter freshwater nine or ten months before spawning. Snake River Basin steelhead
45 enter fresh water from June to October and spawn in the following spring from March to
46 May. The two components, A-run and B-run, are distinguished by their size, the timing
47 of their respective adult migrations, and ocean-age. Because of these timing differences,
48 the A-run component of the Snake River Basin steelhead is most affected by the winter,
49 spring, and summer season fisheries in the Columbia River.

1 **4.11.5.3 Listing status**
2

3 Snake River steelhead were listed as threatened under the ESA in 1997. Critical habitat
4 for Snake River steelhead was designated in 2000 and includes all river reaches
5 accessible to listed steelhead in the Snake River and its tributaries in Idaho, Oregon, and
6 Washington and is well beyond the area that is likely to be directly or indirectly affected
7 by the proposed action.
8

9 **4.11.5.4 Population status and trends**

10 No estimates of historical (pre-1960s) abundance specific to Snake River steelhead are
11 available. An estimated 80% of the total Columbia River Basin steelhead that run above
12 Bonneville Dam (summer and winter steelhead combined) are hatchery fish. Total
13 recent 5-year average escapement above Lower Granite Dam was approximately 71,000,
14 with a natural component of 9,400 (7,000 A-run and 2,400 B-run).
15
16

17 **4.11.5.5 Impacts of human activity on this species**

18
19 When this species was listed, the Biological Review Team that reviewed the status of
20 this species concluded that Snake River Basin steelhead were not presently in danger of
21 extinction, but were likely to become endangered in the foreseeable future (although
22 some members of the team concluded that there was little likelihood that this ESU will
23 become endangered). Although the total (hatchery + natural) run size has increased
24 since the mid-1970s, Snake River Basin steelhead recently experienced severe declines
25 in natural run sizes. The majority of natural stocks of this species have been declining.
26 Parr densities in natural production areas have been substantially below estimated
27 capacity in recent years. Downward trends and low parr densities indicate a particularly
28 severe problem for B-run steelhead, whose loss would substantially reduce life history
29 diversity of Snake River basin steelhead.
30

31 **4.12 Leatherback Sea Turtle**

32
33 **4.12.1 Species Description and Distribution**

34
35 The leatherback is the largest living turtle. Leatherback sea turtles are widely distributed throughout the
36 oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean, and the Gulf of
37 Mexico (Ernst and Barbour 1972). In the Pacific Ocean, they range as far north as Alaska and the Bering
38 Sea and as far south as Chile and New Zealand. In Alaska, leatherback turtles are found as far north as
39 60.34 N, 145.38W and as far west as the Aleutian Islands (Hodge 1979, Stinson 1984). Leatherback
40 turtles have been found in the Bering Sea along the coast of Russia (Bannikov et al. 1971).
41

42 Leatherback turtles undertake the longest migrations of any other sea turtle and exhibit the broadest
43 thermal tolerances (NMFS and USFWS 1998). Leatherback turtles are able to inhabit intensely cold
44 waters for a prolonged period of time because leatherbacks are able to maintain body temperatures
45 several degrees above ambient temperatures. Leatherback turtles are typically associated with
46 continental shelf habitats and pelagic environments, and are sighted regularly in offshore waters (>328
47 ft). Leatherback turtles regularly occur in deep waters (>328 ft), and an aerial survey study in the
48 Northeast found that leatherbacks were sighted in water depths ranging from 3 to 13,618 ft, with a
49 median sighting depth of 131.6 ft (CeTAP 1982). This same study found leatherbacks in waters ranging

1 from 7 to 27.2 °C.

2
3 Leatherback turtles are uncommon in the insular Pacific Ocean, but individual leatherback turtles are
4 sometimes encountered in deep water and prominent archipelagoes. To a large extent, the oceanic
5 distribution of leatherback turtles may reflect the distribution and abundance of their macroplanktonic
6 prey, which includes medusae, siphonophores, and salpae in temperate and boreal latitudes (NMFS and
7 USFWS 1996). There is little information available on their diet in subarctic waters.

8 9 **4.12.2 Life History Information**

10
11 Although leatherbacks are a long lived species (> 30 years), they are somewhat faster to mature than
12 loggerheads, with an estimated age at sexual maturity reported as about 13-14 years for females, and an
13 estimated minimum age at sexual maturity of 5-6 years, with 9 years reported as a likely minimum (Zug
14 and Parham 1996).

15
16 Leatherback sea turtles are predominantly distributed pelagically where they feed on jellyfish such as
17 *Stomolophus*, *Chrysaora*, and *Aurelia* (Rebel 1974). Leatherbacks are deep divers, with recorded dives to
18 depths in excess of 1000 m, but they may come into shallow waters if there is an abundance of jellyfish
19 nearshore. They also occur annually in places such as Cape Cod and Narragansett bays during certain
20 times of the year, particularly the fall.

21
22 Some of the largest nesting populations of leatherback turtles in the world border the Pacific Ocean, but
23 no nesting occurs on beaches under U.S. jurisdiction. However, the Pacific coast of Mexico is generally
24 regarded as the most important breeding ground for nesting leatherback turtles in the world. Leatherback
25 turtles do not generally nest in the insular Central and North Pacific (except the Solomon Islands,
26 Vanuatu, and Fiji). Nesting is widely reported from the western Pacific, including China, southeast Asia,
27 Indonesia, and Australia.

28 29 **4.12.3 Listing status**

30
31 The leatherback was listed as endangered on June 2, 1970 and a recovery plan was issued in 1998.
32 Leatherback turtles are included in Appendix I of the Convention on International Trade in Endangered
33 Species of Wild Fauna and Flora, which effectively bans trade. Critical habitat has not been designated
34 for leatherback turtles in the U.S. Pacific, largely because nesting is not known to occur in U.S. territory
35 and important foraging areas have not been identified.

36 37 **4.12.4 Population status and trends**

38
39 Globally, leatherback turtle populations have been decimated worldwide. The global leatherback turtle
40 population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982), but
41 only 34,500 in 1995 (Spotila et al. 1996). The decline can be attributed to many factors including
42 fisheries as well as intense exploitation of the eggs (Ross, 1979). On some beaches nearly 100% of the
43 eggs laid have been harvested (Eckert, 1996). Eckert (1996) and Spotila et al. (1996) record that adult
44 mortality has also increased significantly, particularly as a result of driftnet and longline fisheries.

45
46 The Pacific population appears to be in a critical state of decline. The East Pacific leatherback
47 population was estimated to be over 91,000 adults in 1980 (Spotila 1996), but is now estimated to
48 number less than 3,000 total adult and subadult animals (Spotila 2000). Leatherback turtles have
49 experienced major declines at all major Pacific basin rookeries. At Mexiquillo, Michoacan, Mexico,

1 Sarti *et al.* (1996) reported an average annual decline in nesting of about 23% between 1984 and 1996.
2 The total number of females nesting on the Pacific coast of Mexico during the 1995-1996 season was
3 estimated at fewer than 1,000. Less than 700 females are estimated for Central America (Spotila 2000).
4 In the western Pacific, the decline is equally severe. Current nestings at Terengganu, Malaysia represent
5 1% of the levels recorded in the 1950s (Chan and Liew 1996).
6

7 The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila
8 1996), but numbers in the Western Atlantic at that writing were reported to be on the order of 18,800
9 nesting females. According to Spotila (pers.comm.), the Western Atlantic population currently numbers
10 about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the Eastern
11 Atlantic (i.e. off Africa, numbering ~ 4,700) have remained consistent with numbers reported by Spotila
12 *et al.* in 1996. Between 1989 and 1995, marked leatherback returns to the nesting beach at St. Croix
13 averaged only 48.5%, but that the overall nesting population grew (McDonald, *et. al.*, 1993). This is in
14 contrast to a Pacific nesting beach at Playa Grande, Costa Rica, where only 11.9% of turtles tagged in
15 1993-94 and 19.0% of turtles tagged in 1994-95 returned to nest over the next five years.
16 Characterizations of this population suggest that it has a very low likelihood of survival and recovery in
17 the wild under current conditions.
18

19 Spotila *et al.* (1996) describe a hypothetical life table model based on estimated ages of sexual maturity
20 at both ends of the species' natural range (5 and 15 years). The model concluded that leatherbacks
21 maturing in 5 years would exhibit much greater population fluctuations in response to external factors
22 than would turtles that mature in 15 years. Furthermore, the simulations indicated that leatherbacks
23 could maintain a stable population only if both juvenile and adult survivorship remained high, and that if
24 other life history stages (i.e. egg, hatchling, and juvenile) remained static, "stable leatherback
25 populations could not withstand an increase in adult mortality above natural background levels without
26 decreasing.
27

28 **4.12.5 Impacts of human activity on the species**

29

30 The primary threats to leatherback turtles are entanglement in fishing gear (e.g., gillnets, longlines,
31 lobster pots, weirs), boat collisions, and ingestion of marine debris (NMFS and USFWS 1997). The
32 foremost threat is the number of leatherback turtles killed or injured in fisheries. Spotila (2000) states
33 that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls and
34 gillnets) in the Pacific during the 1990s is 1,500 animals. He estimates that this represented about a 23%
35 mortality rate (or 33% if most mortality was focused on the East Pacific population). Spotila (2000)
36 asserts that most of the mortality associated with the Playa Grande nesting site was fishery related. As
37 noted above, leatherbacks normally live at least 30 years, usually maturing at about 12-13 years. Such
38 long-lived species can not withstand such high rates of anthropogenic mortality.
39

40 Based on recent modeling efforts, the leatherback turtle population cannot withstand more than a 1%
41 human-related mortality level which translates to 150 nesting females (Spotila *et al.* 1996; Spotila pers.
42 comm.). As noted previously, there are many human-related sources of mortality to leatherbacks; every
43 year, 1,800 leatherback turtles are expected to be captured or killed as a result of federally-managed
44 activities in the U.S. (this total includes both lethal and non-lethal take). An unknown number of
45 leatherbacks are captured or killed in fisheries managed by states. Spotila *et al.* (1996) recommended not
46 only reducing fishery-related mortalities, but also advocated protecting eggs and hatchlings. Zug and
47 Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities
48 and a lack of recruitment stemming from elimination of annual influxes of hatchlings because of intense
49 egg harvesting has caused the sharp decline in leatherback populations.

1 **4.13 Steller Sea lion Critical Habitat**
2

3 The term “critical habitat” is defined in the ESA (16 U.S.C. 1532(5)(A) to mean:
4

5 *(i) the specific areas within the geographic area occupied by the species, at the time it is*
6 *listed in accordance with the provisions of section 4 of this Act, on which are found those*
7 *physical or biological features (I) essential to the conservation of the species and (II)*
8 *which may require special management consideration or protection; and (ii) the specific*
9 *areas outside of the geographical area occupied by the species at the time it is listed in*
10 *accordance with the provisions of section 4 of this Act, upon a determination by the*
11 *Secretary that such areas are essential to the conservation of the species.*
12

13 The ESA also states that “Except in those circumstances determined by the Secretary, critical habitat
14 shall not include the entire geographical area which can be occupied by the threatened or endangered
15 species.”
16

17 By this definition, critical habitat includes those areas that are essential to the “conservation” of a
18 threatened or endangered species. The ESA defines the term “conservation” as: “. . . to use and the use
19 of all methods and procedures which are necessary to bring any endangered species or threatened species
20 to the point at which the measures provided pursuant to this Act are no longer necessary.” That is, the
21 status of the species would be such that it would be considered “recovered.” Therefore, the area
22 designated as critical habitat should contain the physical and biological resources necessary to support
23 and sustain a population of a threatened or endangered species that is sufficiently large and persistent to
24 be considered recovered.
25

26 **4.13.1 Establishment of Steller sea lion critical habitat**
27

28 The areas designated as critical habitat for the Steller sea lion were determined on the basis of the
29 available information on life history patterns of the species, with particular attention paid to land sites
30 where animals haul out to rest, pup, nurse their pups, mate, and molt, and to marine sites considered to be
31 essential foraging areas. The foraging areas were determined on the basis of sightings of sea lions at sea,
32 incidental catch data (Loughlin and Nelson 1986, Perez and Loughlin 1991), and foraging studies using
33 satellite-linked tracking systems. Critical habitat areas were determined with input from NMFS scientists
34 and managers, the Steller Sea Lion Recovery Team, independent marine mammal scientists invited to
35 participate in the discussion, and the public. The proposed rule for establishment of critical habitat for
36 the Steller sea lion was published on 1 April 1993 (58 FR 17181), and the final rule was published on 27
37 August 1993 (58 FR 45269). The following areas have been designated as critical habitat in the action
38 area of one or more of the proposed fisheries (Fig. 4.9).
39

40 **4.13.1.1 Alaska rookeries, haulouts, and associated areas**
41

42 In Alaska, all major Steller sea lion rookeries identified in Table 1 [their Table 1] and major
43 haulouts identified in Table 2 [their Table 2] and associated terrestrial, air, and aquatic zones.
44 Critical habitat includes a terrestrial zone that extends 3,000 feet (0.9 km) landward from the
45 baseline or base point of each major rookery and major haulout in Alaska. Critical habitat
46 includes an air zone that extends 3,000 feet (0.9 km) above the terrestrial zone of each major
47 rookery and major haulout in Alaska, measured vertically from sea level. Critical habitat
48 includes an aquatic zone that extends 3,000 feet (0.9 km) seaward in State and Federally
49 managed waters from the baseline or basepoint of each major haulout in Alaska that is east of

1 144° W long. Critical habitat includes an aquatic zone that extends 20 nm (37 km) seaward in
2 State and Federally managed waters from the baseline or basepoint of each major rookery and
3 major haulout in Alaska that is west of 144° W long.
4

5 **4.13.1.2 Three special aquatic foraging areas in Alaska**

6
7 Three special aquatic foraging areas in Alaska, including the Shelikof Strait area, the Bogoslof
8 area, and the Seguam Pass area.
9

10 **Shelikof Strait Foraging Area**

11
12 Critical habitat includes the Shelikof Strait area in the Gulf of Alaska which . . .
13 consists of the area between the Alaska Peninsula and Tugidak, Sitkinak, Aiaktulik,
14 Kodiak, Raspberry, Afognak and Shuyak Islands (connected by the shortest lines):
15 bounded on the west by a line connecting Cape Kumlik (56°38"/157°26'W) and the
16 southwestern tip of Tugidak Island (56°24'/154°41'W) and bounded in the east by a line
17 connecting Cape Douglas (58°51'N/153°15'W) and the northernmost tip of Shuyak Island
18 (58°37'N/152°22'W).
19

20 **Bogoslof Foraging Area**

21
22 Critical habitat includes the Bogoslof area in the Bering Sea shelf which . . . consists of
23 the area between 170°00'W and 164°00'W, south of straight lines connecting
24 55°00'N/170°00'W and 55°00'N/168°00'W; 55°30'N/168°00'W and 55°30'N/166°00'W;
25 56°00'N/166°00'W and 56°00'N/164°00'W and north of the Aleutian Islands and straight
26 lines between the islands connecting the following coordinates in the order listed:
27

28 52°49.2'N/169°40.4'W; 52°49.8'N/169°06.3'W; 53°23.8'N/167°50.1'W;
29 53°18.7'N/167°51.4'W; 53°59.0'N/166°17.2'W; 54°02.9'N/163°03.0'W;
30 54°07.7'N/165°40.6'W; 54°08.9'N/165°38.8'W; 54°11.9'N/165°23.3'W;
31 54°23.9'N/164°44.0'W
32

33 **Seguam Pass Foraging Area**

34
35 Critical habitat includes the Seguam Pass area which ... consists of the area between
36 52°00'N and 53°00'N and between 173°30'W and 172°30'W.
37

38 **4.13.2 Physical and biological features of Steller sea lion critical habitat**

39
40 For the Steller sea lion, the physical and biological features of its habitat that are essential to the species'
41 conservation are those that support reproduction, foraging, rest, and refuge. Land or terrestrial habitat is
42 relatively easy to identify on the basis of use patterns and because land use patterns are more easily
43 observed. The areas used are likely chosen because they offer refuge from terrestrial predators (e.g., are
44 inaccessible to bears), include suitable substrate for reproductive activities (pupping, nursing, mating),
45 provide some measure of protection from the elements (e.g., wind and waves), and are in close proximity
46 to prey resources.
47

48 Prey resources are the most important feature of marine critical habitat. Marine areas may be used for a
49 variety of other reasons (e.g., social interaction, rafting or resting), but foraging is the most important sea

1 lion activity that occurs when the animals are at sea. Two kinds of marine habitat were designated as
2 critical. First, areas around rookeries and haulouts were chosen based on evidence that lactating, adult
3 females took only relatively short foraging trips during the summer (20 km or less; Merrick and Loughlin
4 1997). These areas were also important because young-of-the-year sea lions took relatively short foraging
5 trips in the winter (about 30 km; Merrick and Loughlin 1997) and are just learning to feed on their own,
6 so the availability of prey in the vicinity of rookeries and haulouts appeared crucial to their transition to
7 feeding themselves.

8
9 Similarly, areas around rookeries are likely to be important for juvenile sea lions. While the foraging
10 patterns of juveniles are only now being studied in the BSAI region, they probably depend considerably
11 on prey resources close to haulouts. Evidence indicates that decreased juvenile survival may be an
12 important proximate cause of the sea lion decline (York 1994, Chumbley *et al.* 1997), and that the growth
13 rate of individual young seals was depressed in the 1980s. These findings are consistent with the
14 hypothesis that young animals are nutritionally stressed. Furthermore, young animals are almost
15 certainly less efficient foragers and probably have relatively greater food requirements which, again,
16 suggests that they may be more easily limited or affected by reduced prey resources or greater energetic
17 requirements associated with foraging at distant locations. Therefore, the areas around rookeries and
18 haulouts must contain essential prey resources for at least lactating adult females, young-of-the-year, and
19 juveniles, and those areas were deemed essential to protect.

20
21 Second, three additional areas were chosen based on (1) at-sea observations indicating that sea lions
22 commonly used these areas for foraging, (2) records of animals killed incidentally in fisheries in the
23 1980s, (3) knowledge of sea lion prey and their life histories and distributions, and 4) foraging studies.
24 In 1980, Shelikof Strait was identified as a site of extensive spawning aggregations of pollock in winter
25 months. Records of incidental take of sea lions in the pollock fishery in this region provide evidence that
26 Shelikof Strait is an important foraging site (Loughlin and Nelson 1986, Perez and Loughlin 1991). The
27 southeastern Bering Sea north of the Aleutian Islands from Unimak Island past Bogoslof Island to the
28 Islands of Four Mountains is also considered a site that has historically supported a large aggregation of
29 spawning pollock, and is also an area where sighting information and incidental take records support the
30 notion that this is an important foraging area for sea lions (Fiscus and Baines 1966, Kajimura and
31 Loughlin 1988). Finally, large aggregations of Atka mackerel are found in the area around Seguam Pass.
32 These aggregations have supported a fishery since the 1970s, and are in close proximity to a major sea
33 lion rookery on Seguam Island and a smaller rookery on Agligadak Island. Atka mackerel are an
34 important prey of sea lions in the central and western Aleutian Islands. Records of incidental take in
35 fisheries also indicate that the Seguam area is an important area for sea lion foraging (Perez and Loughlin
36 1991).

37
38 While many of the important physical and biological elements of Steller sea lion critical habitat can be
39 identified, most of those features (particularly biological features) cannot be described in a complete and
40 quantitative manner. For example, prey species within critical habitat can not be described in detail or
41 with a demonstrated measure of confidence, and the lack of such information is an important impediment
42 to the analysis of fishery effects. Walleye pollock, Atka mackerel, Pacific cod, rockfish, herring, capelin,
43 sand lance, other forage fish, squid, and octopus are important prey items found in Steller sea lion critical
44 habitat but for most (if not all) of these species, we are not able to reliably describe their abundance,
45 biomass, age structure, or temporal and geographic distribution within critical habitat with sufficient
46 clarity and certainty to understand how they interact with Steller sea lions or other consumers, including
47 fisheries. Atka mackerel may be one of the more easily characterized sea lion prey items, but we can not
48 describe their onshore and offshore movements, their distribution inside and outside of critical habitat or
49 in the vicinity of rookeries and haulouts, the relation between eastern and western stocks (or whether

1 separate stocks exist), the causes for their (apparent) two- to three-fold changes in abundance over the
2 last two decades, and so on. Pollock appear to be considerably more dynamic in their spatial and
3 temporal patterns, and their presence within Steller sea lion critical habitat is even more difficult to
4 describe in a detailed or quantitative fashion.

5 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this biological opinion includes the effects of a wide variety of human activities and natural phenomena that may affect the survival and recovery of threatened and endangered species in the action area. NMFS recognizes that natural phenomena and many human activities have contributed to the current status of populations of threatened and endangered species in the action area. Some of those activities have occurred in the past but no longer affect these species. Other activities may have affected, and continue to affect populations of listed species in the action area.

NMFS has managed fisheries under the FMPs for Alaska groundfish in the BSAI and the GOA since 1978 and 1981, respectively. The actions being considered in this biological opinion necessarily include past activity under the FMPs as well as proposed actions for continuing the future fisheries. Therefore, the status of threatened and endangered species in the action area partly reflects past activities conducted under these FMPs and other environmental and human-induced impacts. Consequently, the Environmental Baseline for this biological opinion will include fisheries and other activities associated with these FMPs that occurred prior to the present.

5.1 Environmental Change in the Action Area

This section summarizes the principal natural phenomena and human-related activities in the action area that are either occurring, or have occurred, and are believed to affect designated critical habitat and also the likelihood that threatened and endangered species will survive and recover in the wild. To prepare this section, NMFS relied on numerous published documents; environmental impact statements prepared by NMFS and the Department of the Interior's Minerals Management Service; annual Stock Assessment for Fisheries Evaluation (SAFE) reports for the groundfish fisheries of the BSAI, and GOA; documents that have been transmitted with annual SAFE reports since 1995; biological opinions prepared on Federal activities in the action area; and detailed information on the ecology of this region provided in reports prepared for the Minerals Management Service's Outer Continental Shelf Environmental Assessment Program; Ackley et al. (1995), Bakkala (1993), Hood and Calder (1981), Hood and Zimmerman (1986), Loughlin and Ohtani (1999), and the National Research Council (1996).

5.1.1 Natural climatic variability and the regime shift hypothesis

The North Pacific Ocean is dominated in the winter by an atmospheric phenomenon called the Aleutian Low. The Aleutian Low is a semi-permanent low pressure area that develops late in the year, dominates the winter, and begins to break down during the spring to be replaced by an extensive high pressure system during the summer (Beamish 1993). It can produce changes in atmospheric temperature, storm tracks, ice cover, and wind direction in the BSAI, and GOA (Wyllie-Echeverria and Wooster 1998). Short-term El Niño Southern Oscillation events intensify the Aleutian Low Pressure cell, which enhances wind forcing and precipitation in the North Pacific. This increases the advection of warm water into the northern region of the North Pacific Ocean, increases sea surface temperatures in the BSAI, and GOA,

1 and can trigger a series of oceanographic events that increase ocean productivity. These events cause the
2 marine ecosystems of the BSAI, and Gulf of Alaska to oscillate between “warm” climatic regimes and
3 “cold” climatic regimes (Ebbesmeyer et al. 1991, Trenberth 1990, Brodeur and Ware 1992, Beamish
4 1993, Francis and Hare 1994, Miller et al. 1994, Trenberth and Hurrell 1994; Ingraham et al. 1998).

5
6 From 1940-1941 an intense Aleutian Low was observed over the BSAI, and GOA, this was followed
7 recently from December 1976 to May 1977 with an even more intense Aleutian Low. During this latter
8 period, most of the North Pacific Ocean was dominated by this low pressure system which signaled a
9 change in the climatic regime of the BSAI, and GOA. The system shifted from a “cold” regime to a
10 “warm” regime that persisted for several years (Niebauer and Hollowed 1993). Since 1983, the GOA
11 and Bering Sea have undergone different temperature changes. Sea surface temperatures in the GOA
12 were generally above normal and those in the Bering Sea were below normal. The temperature
13 differences between the two bodies of water have jumped from about 1.1 degrees C to about 1.9 degrees
14 C. Recent evidence now indicates that another regime shift occurred in the North Pacific in 1989.

15 16 **5.1.2 Impacts on Biological Productivity and Animal Populations**

17
18 Most scientists agree that the 1976/77 regime shift dramatically changed environmental conditions in the
19 BSAI and GOA. However, there is considerable disagreement on how and to what degree these
20 environmental factors may have affected both fish and marine mammal populations. Productivity of the
21 Bering Sea was high from 1947 to 1976, reached a peak in 1966, and declined from 1966 to 1997. Some
22 authors suggest that the regime shift changed the composition of the fish community and reduced the
23 overall biomass of fish by about 50 percent (Merrick et al. 1995, Piatt and Anderson 1996). Other
24 authors suggest that the regime shift favored some species over others, in part because of a few years of
25 very large recruitment and overall increased biomass (Beamish 1993, Hollowed and Wooster 1992; 1995;
26 Niebauer and Hollowed 1993, Wespestad et al. 1997a, Wyllie-Echeverria and Wooster 1998).

27
28 All of these authors agree that the regime shift produced environmental conditions that increased the
29 abundance of numerous fish populations, particularly populations of walleye pollock, Atka mackerel,
30 Pacific cod and various flatfish species (Beamish 1993, Niebauer and Hollowed 1993). After
31 reconstructing the strength of different pollock year-classes, Beamish (1993) concluded that the 1978
32 year-class of walleye pollock was the strongest on record and dominated the commercial pollock catch in
33 the 1980s. Beamish reached similar conclusions for several species of salmon, Pacific cod in the GOA,
34 Pacific halibut, Pacific Ocean perch, Atka mackerel, sablefish, and Pacific herring (Beamish 1993). At
35 the same time, small forage fish like capelin, eulachon, and Pacific sandlance declined in bays and the
36 nearshore waters of the BSAI and western and central GOA (Anderson and Piatt 1996). Based on these
37 observations, investigators have generally concluded that the regime shift in the late 1970s dramatically
38 increased the population size of several marine fish species (Beamish 1993, Hollowed and Wooster 1992;
39 1995; Wespestad et al. 1997a, Wyllie-Echeverria and Wooster 1998). Other investigators suggest the
40 regime shift caused the entire structure and composition of the invertebrate and fish communities of the
41 region to change (Brodeur and Ware 1992, Beamish 1993, Francis and Hare 1994, Miller *et al.* 1994,
42 Hollowed and Wooster 1992; 1995; Wyllie-Echeverria and Wooster 1998). In summary, there is
43 considerable disagreement about the effect of these oscillations on the carrying capacity (*K*) of the North
44 Pacific. Perhaps the carrying capacity was increased for some species and decreased for others, or that
45 the entire *K* was either decreased or increased. At this point, the best available scientific and commercial
46 data are equivocal.

47 48 **5.1.1.1 Impacts on listed species environment**

1 Although there are several listed species in the action area, Steller sea lions are used here as an
2 example because it is the listed species for which there is the most information. We will focus
3 this discussion on the impacts of climate variability and regime shifts on the forage species
4 known to be important to Steller sea lions.
5

6 One hypothesis is that during regime shifts, certain species flourish, such as walleye pollock and
7 Pacific cod, at the expense of other more preferable prey species for Steller sea lions. NMFS
8 believes that the situation is much more complicated than this. First, from 1970 to 1980, the
9 annual groundfish catch in the BSAI and GOA ranged from 1.3 to 2.3 million mt, very close to
10 the current catch levels (see Table 5.1). During the same period, the catch of walleye pollock
11 ranged from 1.0 to 1.9 million mt, which comprised about 70 to 83% of the total groundfish
12 catch. The highest groundfish catch during this period was 2.3 million mt in 1972, of which the
13 pollock catch was 1.9 million mt or 83% of the total.
14

15 Second, catches of pollock spawned before the regime shift were high. For example, in the
16 GOA, the catch-per-unit-effort of walleye pollock increased by 6 times from 1961 to 1973-1976
17 (Ronholt et al. 1978). The greatest increases (about 17 times) were observed in Prince William
18 Sound and around Kodiak Island. Ronholt et al. concluded that the biomass of walleye pollock
19 had increased from 15.9 kilograms/hour to 320.5 kilograms/hour between the 1960s and early
20 1970s. Megrey and Wespestad (1990) estimated the total biomass of walleye pollock in the
21 action area at around 12 million mt in 1971 and 1972, which fell below about 10 million mt after
22 1975 (except for 1982).
23

24 The data presented here suggest that walleye pollock comprised the majority of groundfish
25 catches in the BSAI and GOA for almost a decade before the regime shift. Although catch is not
26 always a reliable proxy for biomass, given the magnitude of the catches in the late 1960s and
27 1970s, it does indicate that the pollock biomass had been fairly substantial. In the annual SAFE
28 document (NMFS 1999), NMFS has used models to hindcast back into the 1970s to estimate
29 pollock biomass. However, due to inconsistent survey methodology and the lack of reliable
30 commercial data, NMFS considers those estimates to have very large confidence bounds. For
31 example, in the SAFE NMFS has estimated the pollock biomass in the early 1970s to be about 2
32 million mt, yet the catch from 1972 alone was 1.9 million mt (Table 5.1). These estimates are
33 obviously questionable since it is inconceivable that the fishery caught nearly every fish, and
34 then in 1973 caught another 1.8 million mt of pollock. It is unclear if these catches would have
35 been sustainable in the long term (i.e., it is possible that overfishing was occurring). This
36 supports the argument that pollock biomass was substantial before the regime shift, and that our
37 current estimates of that biomass may not be accurate due to limitations in the available data.
38

39 While biomass was high before the regime shift, it is also reasonable to conclude that the 1976-
40 1977 regime shift produced some very large year-classes of gadids (walleye pollock and Pacific
41 cod). At the same time, the regime shift produced large year classes of other groups, including
42 salmonids (Pacific salmon), clupeids (Pacific herring), scorpaenids (sablefish, Pacific ocean
43 perch, and other rockfish), anoplomatidae (sablefish), and pleuronectids (Pacific halibut) among
44 others (see Beamish 1993). The effects of the regime shift on the productivity of marine species
45 was not limited to the BSAI and GOA. Large year classes were produced as far south as
46 California (Beamish 1993).
47

48 NMFS believes it is reasonable to conclude that the regime shift created environmental
49 conditions that produced very large year classes of gadids (i.e. pollock and Pacific cod).

1 However, because of the historically high catches of gadids before the regime shift occurred,
2 NMFS cannot support the hypothesis that the regime shift favored gadids in a way which would
3 allow them to out compete other fish species and dominate the ecosystem, although the absolute
4 level of biomass is not well known.
5

6 NMFS agrees that many competing factors have contributed to the ecosystem in which Steller
7 sea lions now depend. However, the important question here is whether the diet of Steller sea
8 lions was adversely affected by the regime shift. Specifically, the question has been raised as to
9 whether the increase in pollock abundance is now contributing to the decline of Steller sea lions.
10 From the information available, it seems reasonable to conclude that gadids (i.e., pollock and
11 Pacific cod) were abundant before the regime shift, and that sea lions relied upon them for food
12 before the decline. Therefore, it is unlikely that a change in the structure of the ecosystem,
13 resulting in a dominance of gadids is the sole cause of the current decline.
14

15 Shima et. al.(2000), looked at the GOA and three other ecosystems which contained pinniped
16 populations, similar commercial harvest histories, environmental oscillations, and commercial
17 fishing activity. Of the four ecosystems only the GOA pinniped population (Steller sea lions)
18 were decreasing in abundance. They hypothesized that the larger size and restricted foraging
19 habitat of Steller sea lions, especially for juveniles that forage mostly in the upper water column
20 close to land, may make them more vulnerable than other pinnipeds to changes in prey
21 availability. They further reasoned that because of the behavior of juveniles and nursing females,
22 the entire biomass of fish in the GOA might not be available to them. This would make them
23 much more susceptible to spatial and temporal changes in prey, especially during the critical
24 winter time period (Shima et. al., 2000).
25

26 **5.1.1.2 Impacts on listed species foraging success**

27

28 Ashwell-Erickson and Elsner (1981) studied the energetic value of pollock in the diet of both
29 harbor seals and spotted seals. Their study demonstrated that (a) pollock have lower energy
30 content than herring, but more energy content than invertebrates like squid and crustaceans, (b)
31 harbor seals digested significantly more energy from pollock than herring, and (c) that the
32 energetic value of pollock and herring can depend on how well an animal assimilates its food,
33 which will vary by species and by individual. They recognized that pollock had lower caloric
34 value than fatty species like herring and believed that pinnipeds would have to consume more
35 pollock to make up the difference (7 percent of their body weight per day versus 5 percent of
36 body weight for fattier fish like herring). Recently, several authors have resurrected questions
37 about the caloric value of pollock by arguing that Steller sea lions cannot survive on a diet
38 dominated by pollock because pollock contain fewer calories than species like herring,
39 sandlance, capelin, and smelt (Alverson 1992, Rosen and Trites 2000). A recent study conducted
40 by Rosen and Trites (2000) concluded that captive Steller sea lions lost an average of 6.5% of
41 their body mass after eating only pollock for 11 to 23 days. They concluded that the sea lions in
42 their study would have to consume 35 to 80 percent more pollock than herring to maintain
43 similar energy intakes.
44

45 From the dietary studies alone, it might be reasonable to conclude that a diet that consisted of
46 only walleye pollock might cause Steller sea lions to lose weight, depending on the physiology of
47 an individual sea lion. Unfortunately, feeding studies of captive animals provide little more than
48 a general index of consumption rates that are likely in wild populations because captive animals
49 are given diets consisting of single species of fish and have activity patterns that do not reflect

1 those of wild populations. In the wild, pinnipeds probably feed on species that are most
2 abundant within their foraging range and are the most easy to capture (in Ashwell-Erickson and
3 Elsner 1981). Therefore, no clear conclusion can be drawn from the dietary studies that have
4 been conducted to date.

5
6 Merrick et al. (1997) suggested that Steller sea lions need a diverse diet to survive. This was
7 based on observations that Steller sea lions declined most sharply in areas with the lowest dietary
8 diversity. This observation is supported by the diversity of species found in the diets of Steller
9 sea lions, harbor seals, spotted seals, and fur seals in the action area. Likewise, Steller sea lions
10 are not likely to persist solely on pollock, although pollock is currently the majority of their diet
11 (see Table 5.2).

12
13 Comparisons were made of Steller sea lion diets from the GOA, Kodiak Island area, and
14 southeast Alaska. The diets of Steller sea lions from the different time periods and different
15 regions had percent similarities ranging from 63.85 to 83.85% (coefficients of dissimilarity
16 ranged from 15.87 to 32.30%). Based on these coefficients it is reasonable to conclude that the
17 diets of Steller sea lions presented in Table 5.2 are comparable and that species like walleye
18 pollock, capelin, Pacific cod, and flatfish, occurred in similar proportions. It is also reasonable to
19 conclude that the diets of the eastern population of Steller sea lions contained roughly the same
20 proportions of walleye pollock as the western sea lion population (see Table 5.2). The diet of
21 the eastern population of Steller sea lions was less diverse than the diet of the western sea lion
22 population, and contained a lower percentage of fish like capelin, which have been hypothesized
23 to be more important to Steller sea lions. Given this information, it is difficult to reconcile
24 suggestions that a diet dominated by walleye pollock could cause the decline of Steller sea lions,
25 in part because of the increasing trend of Steller sea lion populations in southeast Alaska and the
26 similar dominance of pollock in their diets.

27
28 If a non-preferable diet was a major factor in the decline of Steller sea lions in Alaska, then it
29 would be expected that other populations of Steller sea lions eating a similar diet would also
30 suffer nutritional stress and possibly population declines. However, this does not appear to be
31 the case. In Southeast Alaska, despite comparable diets, the population of Steller sea lions
32 increased by several percent per year from 1979-1997 (Sease et al. 1993, Strick et al. 1997,
33 Sease et al. 1999, Sease and Loughlin 1999). In British Columbia, Canada (P. Olesiuk,
34 Department of Fisheries and Oceans, unpubl. data) and in Oregon (R. Brown, Oregon
35 Department of Fish and Wildlife, unpubl. data) the Steller sea lions have remained stable.
36 Similarly, populations of Steller and California sea lions in Washington, Oregon, and California
37 have been stable even though they rely on diets dominated by whiting (*Merluccius bilinearis*),
38 another gadid that likely has a lower caloric value than capelin or herring. After the whiting
39 fishery was closed south of 42° N, the number of adult California sea lions observed foraging off
40 the Farallon Islands increased during the fall and observations of adult sea lions increased during
41 the summer (Baraff 1999).

42
43 There are several explanations for this disparity which have been proposed in peer reviewed
44 documents and by the public: (1) the eastern and western populations of Steller sea lions have
45 different physiologies and, as a result, different responses to their diets, (2) the regime shift has
46 altered the diet of the western population differently than the eastern population, which has
47 resulted in the decline in the western stock, and (3) other environmental conditions caused by the
48 regime shift have resulted in the decline of Steller sea lions.

- 1 1. The first explanation is unlikely. It is true that the eastern and western populations of
2 Steller sea lions have genetic differences (Bickham et al. 1998), which could result in
3 different enzymatic responses to similar prey species resulting in different abilities to
4 synthesize proteins. However, this explanation is not likely given the overlapping
5 digestive efficiencies of various pinniped species on diets of pollock, herring, and other
6 food items (Ashwell-Erickson and Elsner 1981, Rosen et al. 2000a). It would be
7 extremely unlikely for the two sea lion populations to have such different responses to
8 similar diets. Therefore, this explanation is rejected.
9
- 10 2. The second explanation is possible, but unlikely. The earlier regime shift of 1940-1941
11 (warm to a cool phase) was very intense. Yet the best available information on the
12 abundance of Steller sea lions prior to the 1970s suggests they did not experience sharp
13 population declines similar to the 1970s and 1980s after the regime shift of 1976/77
14 (cool to a warm phase). The available information on the size of the Steller sea lion
15 population in the mid-1950s also suggests that Steller sea lions probably had not declined
16 in response to the regime shift of 1940-1941 (Kenyon and Rice 1961, Merrick et al.
17 1987). Care is required in drawing any conclusions from these data, but it does suggest
18 that Steller sea lions are not always disadvantaged by regime shifts, which suggests other
19 contributing factors to the current decline.
20

21 Some populations of mammals experience declines similar to the magnitude observed
22 with Steller sea lions, but these mammals are usually short-lived, and have very high
23 fecundity. Long-lived mammals such as sea lions rarely experience declines of 80 to 90
24 percent except when they are struck by disease or some other catastrophic factor. “K”
25 selected species like Steller sea lions grow slowly, have low fecundity, and have
26 developed physiological responses to resist dramatic population declines caused by
27 natural environmental change. Since they are long lived, their breeding populations are
28 protected against short term changes in juvenile survival (Lowry et al. 1982). However,
29 long term adverse affects on survival would have devastating effects on the population as
30 it would take many decades to rebuild a population.
31

32 Furthermore, as described above, the current diet of Steller sea lions in both the eastern
33 and western populations is dominated by pollock. Because the eastern population is
34 increasing, it seems unlikely that the same pattern of prey consumption seen in both
35 stocks would cause a decline in the western stock and an increase in the eastern stock.
36 Again, other factors are likely contributing to the difference between these two
37 populations.
38

- 39 3 It seems unlikely that Steller sea lions would respond to a regime shift with population
40 declines of 80% or more, particularly given the fact that we believe regime shifts happen
41 at 30 to 50 year intervals. It is unreasonable to expect this species to recover quickly
42 after each regime shift. It is important to note that NMFS does not suggest that regime
43 shifts would not cause Steller sea lions to decline at all, rather, that declines of 80 to 90%
44 in the face of short-term, environmental change would imply that Steller sea lions are
45 poorly adapted to changes in their environment, after surviving for thousands of years in
46 that environment.
47

48 Based on the best scientific and commercial data available, NMFS concludes the following:
49

- 1 ▶ Gadids such as walleye pollock and Pacific cod were dominant in the pelagic groundfish
2 community both before and after the regime shift;
- 3
- 4 ▶ The regime shift created environmental conditions that produced large year-classes of
5 many species in the BSAI and GOA (including gadids);
- 6
- 7 ▶ A diet solely of pollock may contribute to nutritional stress of Steller sea lions; and,
- 8
- 9 ▶ The regime shift of 1976-1977 was not solely responsible for the decline of the western
10 population of Steller sea lions.
- 11

12 Therefore, NMFS believes that the cause of the continued decline of Steller sea lions is not
13 solely a function of the regime shift, and that other factors such as fishing, predation, and
14 harassment are also likely contributors to the decline. These other factors will be discussed
15 further in this biological opinion. The existence of these contributing causes of the decline do
16 not relieve NMFS of the responsibility to insure, under the ESA, that any action authorized by
17 NMFS is not likely to jeopardize the continued existence of listed species or adversely modify
18 critical habitat for any listed species.

19 **5.1.2 Possible changes in the carrying capacity of the Bering Sea and Gulf of Alaska**

20
21 Populations can experience abrupt and dramatic declines because of dramatic reductions in
22 environmental carrying capacity (Odum 1971). Such a reduction could explain the decline of top
23 predators in the BSAI and GOA. One hypothesis argues that the regime shift favored gadids which
24 decreased the quality of the natural environment for pinnipeds and some seabirds, due to the lower
25 energy content compared to herring and capelin that theoretically dominated the pelagic community
26 during the "cold" regimes. As a result, this theory would indicate that the regime shift lowered the
27 carrying capacity of the BSAI and GOA for species like Steller sea lions, northern fur seals, harbor seals,
28 kittiwakes, and murre.

29
30 Conversely, the other side of this debate accepts that the climatic regime shifted in the mid-1970s and
31 that the regime shift produced large year-classes of groundfish in 1976-1977 (NMFS 1998). This would
32 not necessarily reduce the carrying capacity of the system for pinnipeds, such as Steller sea lions,
33 northern fur seals, harbor seals, kittiwakes, or murre. In fact, it could possibly increase the carrying
34 capacity.

35
36 All animal populations fluctuate over time; sometimes in response to changes in their physical
37 environment, sometimes in response to changes in their ecological relationships (predator-prey
38 dynamics), and sometimes in response to combinations of the two. Large, natural variability often masks
39 the effects of human activity on natural ecosystems and populations. Because of the complex
40 relationships between wild populations, their physical environment, and their ecological relationships, it
41 is extremely difficult to assign a populations' decline to a single cause.

42
43 Further complicating our understanding of these natural phenomena, a major expansion of the groundfish
44 fisheries occurred in the BSAI and GOA during the 1977-1978 regime shift. As these groundfish
45 fisheries expanded, numerous investigators expressed concern about the effects of the expanded fisheries
46 on populations of pinnipeds and seabirds in the North Pacific Ocean (Alverson 1991, Ashwell-Erickson
47 and Elsner 1981). Several populations of seabirds and pinnipeds declined from the early to mid-1980s.
48 As a result, scientists and fishery managers began to debate the relative roles of the regime shift and the
49

1 groundfish fisheries on trophic relationships in the BSAI and GOA (Lowry et al. 1982, Alaska Sea Grant
2 1993). When Steller sea lions were listed as threatened in 1990, then reclassified to endangered in 1997,
3 the debate increased in intensity.
4

5 It is clear, given an almost 90% reduction in the western population of Steller sea lions, that the
6 environmental carrying capacity has somehow been reduced. The decline has been so severe, and
7 continuous, that Steller sea lions have been listed as an endangered species under the ESA, and is
8 thereby given all the substantive protections associated with that Act. Given the equivocal data
9 surrounding the dietary needs of Steller sea lions, the regime shift hypothesis, and massive population
10 declines, it is highly unlikely that natural environmental change has been the sole underlying cause for
11 the decline of Steller sea lions. Therefore, this consultation looks to other possible causes of the decline
12 recognizing that environmental change is an important component in this equation, and may combine
13 with other factors to contribute to the past and continuing decline of Steller sea lions.
14

15 **5.2 Impacts of Killer Whale Predation on Natural Mortality of Listed Species**

16
17 The following discussion summarizes the best available scientific information on the magnitude and
18 likely impacts of Orca predation on listed species in the action area. This information is typically
19 presented in the Status of Species section. However, given the magnitude of the impacts, especially on
20 Steller sea lions, it is appropriate to discuss this source of natural mortality in the Baseline.
21

22 **5.2.1 Steller sea lions**

23
24 Killer whale predation on Steller sea lions has likely been a considerable source of natural mortality for
25 the species. During the 1970s, when Steller sea lions were at their highest recorded levels (about
26 200,000 animals), predation by killer whales, although numerically large, was probably a minor factor in
27 population growth. Today, given the nearly 90% decline in the population size of Steller sea lions, it is
28 likely that the impact of similar levels of killer whale predation is more significant and may be affecting
29 the species ability to recover.
30

31 For this analysis, it has been assumed that predation on Steller sea lions is by transient-type killer whales
32 only (Barrett-Lennard et al. 1995, Forney et al. 1999). A status report on the eastern North Pacific
33 transient stock of killer whales is included in Forney et al. (1999). The distribution of this stock ranges
34 from waters off Alaska south to California. The stock is described as a trans-boundary stock, including
35 killer whales from British Columbia (Canada) and the U.S. A minimum population estimate of 336 is
36 reported by Forney et al. (1999). No data are reported concerning trends in abundance.
37

38 Regarding predation by killer whales on Steller sea lions, Frost et al.(1992) reported that an unusual
39 number of killer whales appeared inshore in waters of the southeastern Bering Sea in the summers of
40 1989 and 1990. Multiple sightings of killer whales were reported from Bristol Bay and the Kuskokwim
41 Bay, where killer whales had been seen only rarely in previous years. Of the 27 reported sightings in
42 1989 and 1990, one sighting of 4 whales near Round Island involved chasing of a Steller sea lion.
43

44 The most comprehensive paper on the impact of killer whale predation on Steller sea lion populations is
45 by Barrett-Lennard et al. (1995). In this report, the authors summarize the results of a survey of mariners
46 regarding observations of killer whale predation on Steller sea lions, available data on the diet of killer
47 whales based on stomach content analysis from stranded killer whales in Alaska and British Columbia,
48 an analysis to estimate the population size of transient killer whales in the eastern North Pacific, and the
49 results of a simulation analysis on the impacts of killer whale predation on Steller sea lion populations.

1 The authors concluded the following:

- 2
- 3 • There have been surprisingly few observations of killer whale predation on Steller sea lions by
- 4 mariners and that most of the attacks that have been witnessed have been directed at adult
- 5 animals;
- 6
- 7 • Pup mortality of Steller sea lions caused by killer whales is likely underestimated by techniques
- 8 based on direct observations;
- 9
- 10 • Two of eight stomachs (25%) from stranded killer whales contained at least some marine
- 11 mammal tissues, including tissues from Steller sea lions;
- 12
- 13 • There are at least 250 transient killer whales in the eastern North Pacific, where approximately
- 14 50% of these occur south of Prince William Sound and 50% occur in Prince William Sound or to
- 15 the west;
- 16
- 17 • Killer whale predation did not cause the observed decline in sea lion abundance between the
- 18 1970s and the 1990s, but at current population levels may be a contributing factor to the current
- 19 decline; and
- 20
- 21 • At a population size of 125 killer whales and 42,000 Steller sea lions, 18% of the deaths
- 22 occurring annually could be caused by killer whale predation. However, the authors noted that
- 23 the results of the simulations “are not better than the assumptions they are built on” (p. 38).
- 24

25 In the concluding paragraph of the report, the authors also noted that “A better understanding of the

26 impact of killer whale predation on Steller sea lion populations requires more precise knowledge of the

27 age-specificity and seasonality of killer whale predation patterns.”

28

29 As presently drafted, NMFS considers the conclusions of the Barrett-Lennard et al. report adequate to

30 support the conclusion that killer whale predation on the current population of Steller sea lions in western

31 Alaska is potentially significant and should be investigated further. However, prior to final publication,

32 NMFS believes the following concerns need to be addressed by the authors of the report. First,

33 considerable uncertainty (as noted by the authors) exists in the estimates of parameters used to run the

34 simulations. At a minimum, this uncertainty should be incorporated into the estimation process and used

35 to provide some type of confidence interval around specific output parameters. For example, there is no

36 information available that supports the parameters used to conclude that the vulnerability of pups to killer

37 whale predation is five times the vulnerability of 5 to 20 year old animals. Likewise, there are

38 inadequate data to support the value used in the model regarding the proportion of Steller sea lions in the

39 killer whale diet. While it is unreasonable to expect the authors to provide the information needed to

40 reduce uncertainty in the parameters used in their model, it is clear that additional research is needed

41 before reliable conclusions regarding the impact of killer whale predation on Steller sea lions can be

42 finalized.

43

44 Second, there are a number of problems in the way the model was constructed. These include, but are

45 not limited to, the following:

46

- 47 • The authors assumed that density dependent effects in the dynamics of the sea lion
- 48 population model were unimportant because the range of population sizes of Steller sea
- 49 lions used in the simulations was well below maximum levels. This would be a

1 reasonable approach if it could be assumed that the carrying capacity (K) for this
2 population was constant. However, as noted by several authors (Alverson 1992, Rosen
3 and Trites 2000a) such an assumption seems unwarranted regarding Steller sea lions.
4 Therefore, the underlying population model for Steller sea lions needs to be revised to
5 account for the possibility of density dependent effects in sea lion dynamics due to a
6 reduction in the carrying capacity of the environment for Steller sea lions.
7

- 8 • The authors assumed that killer whale predation on Steller sea lions was additive rather
9 than assuming that at least some of the mortality was compensatory. This difference is
10 likely to be insignificant in models where the population growth rate is independent of
11 density, but is likely to be very important where the growth rate of the sea lion
12 population is affected by its status relative to K. Therefore, one approach that needs to
13 be incorporated into the analysis is the assumption that the mortality of sea lions caused
14 by killer whale predation is entirely compensatory in a density dependent model.
15

16 As noted above, the available data are inadequate to develop a reliable estimate of what fraction of total
17 Steller sea lion mortality is due to predation by killer whales. However, as a first-order approximation,
18 the following simplified approach was developed. The results are similar to those reported by Barrett-
19 Lennard et al. Here NMFS has estimated the number of Steller sea lions eaten by a population of killer
20 whales, the mortality rate associated with that level of predation, and the percentage of total mortality
21 due to killer whale predation. The number of sea lions eaten by a specified number of killer whales was
22 calculated as the product of:

- 23 1. The amount of Steller sea lions eaten by an average sized killer whale in kg/day;
- 24 2. The number of days killer whales feed on Steller sea lions;
- 25 3. The number of killer whales in the population;
- 26 4. The average weight of a Steller sea lion; and
- 27 5. The percent of Steller sea lions in the diet of killer whales.
28
29

30 In the analysis it was assumed that the Steller sea lion population was declining at 5% per year and that
31 killer whale predation was additive. Using the scaled vital rates reported by York (1994), the crude death
32 rate in the absence of killer whale predation was estimated to equal 0.20. It was also assumed that the
33 average size of a Steller sea lion was 160 kg and that killer whales consume 74 kg/day/animal (Barrett-
34 Lennard et al. 1995). Clearly, the uncertainty included in Table 5.3 is only a subset of the actual
35 uncertainty associated with such a calculation, so the reported results should only be considered as a
36 rough approximation to the real impact of killer whales in the North Pacific on the western stock of
37 Steller sea lions.
38

39 The results (Table 5.3) indicate that killer whale predation by 125 killer whales on a population of 42,000
40 Steller sea lions could cause an annual mortality of between 5% to 8%. Expressed as a fraction of the
41 crude death rate, killer whale predation could be responsible for a minimum of 20% or as much as 27%
42 of total mortality. The uncertainty in these results are likely underestimated, as the fraction of Steller sea
43 lion biomass in the diet of killer whales that are located in the range of the western stock of Steller sea
44 lions is unknown. For example, if the percent of killer whale diet made up of sea lions was only 5%
45 (rather than between 10% and 15% assumed in Barrett-Lennard [1995]), the resulting annual mortality
46 associated with killer whale predation would be only 2.5%, while if there were 250 killer whales the
47 annual mortality associated with a diet of 25% sea lions would be 13%.
48

5.3 Impact to Water Quality Due to Human Population Growth in the Action Area

As the size of human communities increases, there is an accompanying increase in habitat alterations for housing, roads, commercial facilities, and other infrastructure. The impacts of these activities on landscapes and the biota they support increases as the size of the human population expands. The Alaska population has increased by almost 50 percent in the past 20 years, most of that increase has occurred in the Cities of Anchorage and Fairbanks (Table 5.4). Outside of the City of Anchorage, few of the cities, towns, and villages would be considered urbanized. Despite low levels of industrialization in the action area, some commercial and industrial facilities in the action area have had, or have the potential for significant, adverse effects on the terrestrial, coastal, and marine environments, primarily because of their potential effects on water quality.

Four superfund sites occur in the action area: Adak Naval Air Station (Aleutians West), Elmendorf Air Force Base (Borough of Anchorage), Fort Richardson Army Base (Borough of Anchorage), and the U.S. Department of Transportation's Standard Steel and Metals Salvage Yard ((Borough of Anchorage).

The Naval Air Station at Adak covers about 64,000 acres on the Island of Adak near the western end of the Aleutian Island archipelago. Adak Island became a military base in 1942 and has been controlled by the U.S. Navy since 1950. In 1986, the Navy identified 32 areas that potentially received hazardous substances, including chlorinated solvents, batteries, and transformer oils containing polychlorinated biphenyls (PCBs) over a period of 40 years. Investigations on the island focused on two areas: the Palisades Landfill and Metals Landfill. Disposals had stopped at the Palisades landfill in the 1970s and the landfill was covered. The Metals landfill contains a hazardous waste pile under the Resource Conservation and Recovery Act and a closure plan is being developed the site.

The cities of Kodiak and Unalaska both have wastewater treatment plants, along with the City of Anchorage and several cities in the Kenai borough. Most of the industrial facilities in the action area (outside of Anchorage and the Kenai Borough) are involved in seafood processing. Canneries or land-based processors occur at Adak, Anchorage, Chignik, Cordova, Dillingham, Egegik, Emmonak,, False Pass, Homer, Kenai, King Cove, King Salmon, Kodiak, Larsen Bay, Nikiski, Ninilchik, Nome, St. Paul, Sand Point, Savoonga, Seward, Soldotna, Togiak, Toksook Bay, Unalaska, Valdez, and Whittier.

In the 1970s, fish and shellfish waste discharged from mobile and shore-based processors at Kodiak, Dutch Harbor, and Akutan polluted coastal waters around those communities (Jarvela 1986). In 1976, waste was discharged at Dutch Harbor. In 1983, the shore-based Trident Seafoods plant at Akutan released between codfish and crab wastes into Akutan Harbor before the plant was destroyed by fire. Sonar surveys of Akutan Harbor identified a waste pile that was about 7 m thick and 200 m in diameter. In 1998, the list of impaired waters that was prepared by the Alaska Department of Environmental Conservation included water bodies in Cold Bay, Dutch Harbor, and Kodiak that had been impaired by seafood processing, logging operations, military materiel, or fuel storage. Although total maximum daily loads will not be developed for these facilities before this biological opinion is completed, the effects of these facilities appear to be localized and would not be expected to adversely affect threatened or endangered species under NMFS' jurisdiction.

As the human population expands, the risk of disturbance to listed species in the action area, especially Steller sea lions, also increases. Several studies have noted the potential adverse effects of human disturbance on Steller sea lions. Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions. Sea lion reaction to occasional disturbances ranges from no reaction at all to complete and immediate departure from the haulout area.

1 The type of reaction appears to depend on a variety of factors. When sea lions are frightened off
2 rookeries during the breeding and pupping season, pups may be trampled or even abandoned in extreme
3 cases. Sea lions have temporarily abandoned some areas after repeated disturbance (Thorsteinson and
4 Lensink 1962), but in other situations they have continued using areas after repeated and severe
5 harassment. Johnson et al. (1989) evaluated the potential vulnerability of various Steller sea lion haulout
6 sites and rookeries to noise and disturbance and also noted a variable effect on sea lions. Kenyon (1962)
7 noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated
8 disturbance. A major sea lion rookery at Cape Sarichef was abandoned after the construction of a light
9 house at that site, but then has been used again as a haulout after the light house was no longer inhabited
10 by humans. The consequences of such disturbance to the overall population are difficult to measure.
11 Disturbance may have exacerbated the decline, although it is not likely to have been a major factor.
12

13 **5.4 Historical Harvest of Currently Listed Species**

14 **5.4.1 Subsistence harvests of listed species**

15
16
17 The MMPA authorizes the taking of any marine mammal by Alaska Natives for subsistence purposes or
18 for the purpose of creating and selling authentic native articles of handicrafts and clothing, given that it is
19 not done in a wasteful manner (MMPA, Section 101[b]). The ESA also contains provisions that allow
20 for the continued subsistence use of listed species. Both the ESA and the MMPA contain provisions that
21 allow regulation of the subsistence harvest of endangered, threatened, or depleted species, if necessary
22 (NMFS 1995).
23

24 **5.4.1.1 Steller sea lions**

25
26 Subsistence harvests of Steller sea lions from 1960 to 1990 have been estimated at 150 animals
27 per year (Alverson 1992), but the estimate was subjective and not based on any referenced data.
28 This estimate is well below the levels observed in the 1990s. More recent estimates (Wolfe and
29 Mishler 1993, 1994, 1995, 1996) indicate a mean annual subsistence take of 448 animals from
30 the western U.S. stock (i.e., the endangered population) from 1992 to 1995, declining to 178
31 (with 95% confidence limits of 137 to 257) in 1998. It is likely that the earlier estimates of
32 subsistence underestimate of the actual number of animals taken for subsistence. The majority of
33 sea lions have been taken by Aleut hunters in the Aleutian and Pribilof Islands. The great
34 majority (99%) of the statewide subsistence take was from west of 144°W long. (i.e., the range of
35 the western population).
36

37 The overall impact of the subsistence harvest on the western population of Steller sea lions is
38 determined by the number of animals taken, their sex and age class, and the location where they
39 are taken. As is the case for other sources of mortality, the significance of subsistence harvesting
40 may increase as the western population decreases in size unless the harvesting rate is reduced
41 accordingly. The current subsistence harvest represents a large proportion of the potential
42 biological removal that was calculated for the western stock of the Steller sea lion pursuant to the
43 MMPA (Hill and DeMaster 1998). However, the subsistence harvest accounts for only a
44 relatively small portion of the animals lost to the population each year. For example, a
45 population of about 40,000 growing at 8% per year would be expected to increase to 43,200 after
46 one year; a gain of 3,200 animals. If, instead, that population is observed to decline by about 5%,
47 then it would drop to 38,000, a loss of 2,000. The difference between expected and observed is,
48 then, 5,200 animals, of which a subsistence harvest of say, 250, would account for 5%. Thus, the
49 numbers of animals currently taken must contribute to the decline of sea lions, particularly at

1 certain locations, but are not sufficient to explain the decline throughout the range of the
2 population. It is not known, however, whether the current harvest levels inhibit recovery at
3 selected sites.

4 5 **5.4.1.2 Large cetaceans**

6
7 Native Alaskans harvested whales in the eastern north Pacific for many years prior to the arrival
8 of commercial whalers in the 19th century. The Inuit of the Bering Sea coast of Alaska have been
9 whalers for centuries. Aboriginal whaling took place in three main areas in the eastern north
10 Pacific (1) the west and northwest coasts of Alaska, (2) the Aleutian Islands and the Alaska
11 peninsula, and (3) the coasts of Vancouver Island and Washington.

12
13 The Aleuts of the Aleutian Islands and the Alaska peninsula hunted whales with hand-thrown
14 spears. They likely harvested humpback whales, gray whales and possibly right whales. Along
15 the coast of British Columbia and Washington, whales were hunted by Nootka, Makah,
16 Quilleute, and Quinault tribes, who targeted gray and humpback whales, and possibly right
17 whales. The number of whales that were taken in these fisheries is unknown (Scarff 1986).

18 19 **5.4.2 Commercial harvest of listed species**

20 21 **5.4.2.1 Steller sea lions**

22
23 In 1959, the Bureau of Commercial Fisheries awarded a contract to a commercial fishing
24 company to develop techniques for harvesting sea lions in Alaskan waters. The two-fold purpose
25 of the contract was to reduce the sea lion herds (because of alleged depredations on salmon and
26 halibut fisheries) and to provide an economical source of protein for fur farms, fish hatcheries,
27 and similar purposes (Thorsteinson and Lensink 1962). In 1959, 630 sea lion bulls were killed
28 in an experimental harvest, but the harvest proved uneconomical. Another study was contracted
29 by the Bureau of Indian Affairs of the Department of Interior to analyze the feasibility of a
30 commercial sea lion harvest in Alaska. A total of 45,178 pups of both sexes were killed in the
31 eastern Aleutian Islands and GOA between 1963 and 1972 (Merrick et al. 1987). Such harvests
32 could have depressed recruitment in the short term and may have explained significant portions
33 of the declines noted at some sites in the eastern Aleutian Islands or the GOA. Bigg (1988)
34 provides a minimal accounting of the thousands of sea lions killed at rookeries and haulouts in
35 British Columbia from 1912 to 1968. The impact of such killing on numbers of sea lions in
36 southeast Alaska undoubtedly had a local, temporal effect at the time of the harvests. However,
37 the eastern population of Steller sea lions has been increasing at 2-3 % per year during the 1990s.
38 Therefore, historical harvests do not seem to be impacting current population growth .

39
40 Commercial harvests of adult, male sea lions in 1959 likely had no significant effect on
41 population trends. However, harvest of over 45,000 pups from 1963 to 1972 contributed to local
42 population trends in the 1960s through the early 1980s in the GOA and the eastern Aleutian
43 Islands. Similarly, subsistence harvests prior to the 1990s were not measured but may have
44 contributed to population decline in localized areas where such harvests were concentrated.

45 46 **5.4.2.2 Northern fur seals**

47
48 Commercial harvests of marine mammals in the Bering Sea began with the industrial harvest of
49 northern fur seals in the Pribilof Islands in the late 1700s. The size of the fur seal population on

1 the Pribilofs was estimated at 2.5 million animals (Kenyon et al. 1954). From its beginning until
2 about 1835, commercial harvests of these fur seals were “extravagant, wasteful, and largely
3 unrecorded” (Kenyon et al. 1954). By 1803, about 800,000 skins had accumulated in storehouses
4 on the Pribilofs, 700,000 of which “were thrown into the sea as worthless.”
5

6 By 1834, the northern fur seal population had declined to less than 1,000,000 animals, which
7 resulted in a seven-year ban on killing fur seals to allow the population to recover. From the
8 1840s to the 1860s, the harvest of fur seals increased from 10,000 animals per year to about
9 75,000 animals. In 1868, when the U.S. first occupied the Pribilof Islands, 242,000 fur seals were
10 harvested. From 1870 to 1909, commercial companies from the U.S. conducted the fur seal
11 harvest accompanied by the onset of pelagic sealing.
12

13 The practice of pelagic sealing was not selective and resulted in the death of a high percentage of
14 pregnant, female fur seals. From the 1860s to about 1911, more than 950,000 fur seals were
15 taken by pelagic sealers. At the same time, more than 2,900,000 fur seals were taken on the
16 Pribilof Islands. The combination of pelagic sealing and land-based sealing dramatically
17 reduced the size of the fur seal population: by 1897, the fur seal population had been reduced to
18 about 400,000 animals; by 1911, it had been reduced to about 215,000 animals. Because the
19 takes were greatly reducing the fur seal stock, Great Britain (for Canada), Japan, Russia, and the
20 United States ratified the Treaty for the Preservation and Protection of Fur Seals and Sea Otters
21 in 1911. The treaty prohibited pelagic sealing and required a reduction in the taking of seals on
22 the land.
23

24 From 1912 to the mid-1950s, the population slowly increased to about 1,500,000 animals with a
25 harvest of about 60,000 male seals each year. In the early 1950s, biologists realized that the fur
26 seal population had ceased to grow and agreed to experiment with increasing the harvest of male
27 fur seals and begin another harvest of female fur seals in the hope that the fur seal population
28 would increase further. In 1953, the harvest of female fur seals began with the death of about 850
29 female fur seals. This harvest peaked in 1957, with 47,413 animals. From its discovery until the
30 mid-1950s, more than 7.8 million fur seals were taken in commercial harvests. In 1957, the
31 signatories of the 1911 Treaty ratified a new agreement, the Interim Convention on the
32 Conservation of North Pacific Fur Seals, for the conservation, research, and harvesting of fur
33 seals. About 18,000 female fur seals were killed each year from 1963 to 1968.
34

35 When this experiment ended, more than 300,000 female fur seals had been killed in an attempt to
36 increase the productivity of the population and, as a result, the size of the commercial harvest
37 (Kenyon et al. 1954). The harvest did not increase the population’s productivity as expected;
38 instead, pup production on St. Paul Island declined by 7 percent per year from 1975 to 1983 and
39 production on St. George declined by 6 percent per year from 1973 to 1990. From 1950 to 1988,
40 the fur seal population declined by over 50 percent (to about 1 million animals).
41

42 The authority of the 1957 Convention was extended in 1963, 1969, 1976 and 1980. Under the
43 terms of the 1980 extension, the Convention expired on October 14, 1984. In consultation with
44 the U.S. Departments of State and Justice, and the Marine Mammal Commission, the United
45 States declined to sign an extension. It was determined that no commercial harvest could be
46 conducted under existing domestic law and, therefore, the commercial harvest on St. Paul Island
47 was terminated. Management of the fur seals then reverted to the MMPA. Accordingly, on July
48 8, 1985, NMFS issued an emergency interim rule to govern the subsistence taking of fur seals for
49 the 1985 season under the authority of section 105(a) of the Fur Seal Act. A final rule was

1 published on July 9, 1985. In 1988, the Pribilof Island fur seal stock was declared depleted under
2 the provisions of the MMPA of 1972 (NMFS 1993).
3

4 **5.4.2.4 Large cetaceans**

5
6 By the late 1800s, commercial whaling had severely reduced the population of bowhead whales
7 in the Bering and Chukchi Sea and had left the Pacific right whale population nearly extinct.
8 The modern era of pelagic whaling in the north Pacific began in 1952, with a single factory ship
9 operating off Asia. From 1954 to 1961, only three factory ships operated, but this type of whaling
10 extended eastward to the American side of the Pacific. In 1963, the arrival of seven factory ships
11 from Japan and USSR to whaling grounds in the north Pacific partially resulted from the
12 protection of blue whales in the Antarctic and strict quotas on other Antarctic species. These
13 pelagic whalers concentrated on humpback whales in the early 1960s, switched to fin whales in
14 the mid-1960s, then switched to sei whales in the late 1960s. In 1970s, whalers in the north
15 Pacific focused on hunting sperm whales and took between 8,000 to 10,000 per year during that
16 period. From the 1950s to the 1970s, an estimated 5,671 blue whales, more than 21,000 fin
17 whales, 40,000 sei whales, 30,143 humpback whales, and 210,000 sperm whales had been killed
18 in the North Pacific ocean.
19

20 **Blue Whales**

21
22 From 1889 to 1965, about 5,761 blue whales were killed in the North Pacific Ocean
23 (Braham 1991). The effects of these deaths on the blue whale population can be seen in
24 the catch data from Japan. In 1912, 236 blue whales were killed; in 1913, 58 blue
25 whales were killed; in 1914, 123 blue whales were killed; and from 1915 to 1965, the
26 numbers of blue whales that were killed declined continuously (Mizroch et al. 1984a).
27 In the eastern North Pacific, 239 blue whales were killed off the California coast in 1926.
28 Off the Aleutian Islands, Japanese whalers killed 70 blue whales each year from the late
29 1950s to the early 1960s (Mizroch et al. 1984a).
30

31 **Bowhead Whales**

32
33 Prior to commercial whaling, the bowhead whale population was estimated at 14,000 to
34 26,000 animals (Breiwick et al. 1981). Commercial whalers killed an estimated 19,000 to
35 21,000 whales from 1848 to 1915. In 1912, their population declined to about 600
36 animals.
37

38 **Fin Whales**

39
40 Fin whales were not hunted until the 20th century, with the advent of fast-moving boats
41 and explosive harpoons. In the 1940s, whalers extended into the North Pacific Ocean to
42 hunt fin whales. From about 1940 to 1962, 80% of the whales killed in the North Pacific
43 were fin whales, which were hunted in five major areas: off the Kamchatka Peninsula to
44 near Attu Island, the south side of the Aleutians, north of Unalaska Island, west of St.
45 Matthew Island and near Cape Navarin.
46

47 From 1954 through 1962, whalers killed about 1,560 fin whales per year (Nishiwaki
48 1966). Between 1963 and 1974 about 21,474 fin whales were killed in the North Pacific
49 Ocean (Tillman 1977; see Table 5.5). From 1960 to 1967, about 4,000 fin whales of

1 these whales were killed in the Gulf of Alaska. Originally, the global population of fin
2 whales was around 470,000; between 70,000 and 75,000 individuals remain.
3

4 **Gray Whales**

5
6 The gray whale fishery began in the early 1800s. In 1957, Scammon discovered the
7 calving lagoons in Mexico: the whales were hunted heavily there and by 1875, Scammon
8 predicted that gray whales would be extinct (Lowry et al. 1982). Over 9,000 gray whales
9 were taken from 1846 to 1900 (Rice and Wolman 1982; Brownell 1977). With the
10 advent of modern whaling techniques in the early 20th century, whaling effort increased
11 again and almost 1,000 additional whales were killed between 1905 and 1948, when the
12 IWC banned further hunting of this species. Between 1959 and 1969, 316 gray whales
13 were taken off California for scientific purposes. Since the 1960s, Russia has conducted
14 a regulated, annual hunt of gray whales to provide food for coastal Siberian eskimos; the
15 average annual take is 165 per year (Wolman and Rice 1979). The average annual take
16 of gray whales by Alaskan eskimos has been less than 3 per year since 1970, reaching a
17 maximum of seven in 1975.
18

19 **Humpback Whales**

20
21 In the North Pacific, humpback whale populations were targeted by commercial whaling
22 throughout the 1950s until they were protected in 1965 (Tillman 1975). Before whaling
23 began, about 15,000 humpback whales are estimated to have occupied the North Pacific.
24

25 **Right Whales**

26
27 Whaling ships from Britain, France, and the United States began hunting right whales in
28 the East China Sea around 1822. Whaling ships from the U.S., France, Britain, Germany,
29 and Hawaii began hunting right whales in waters off Kodiak Island around 1835, with a
30 peak from 1840-1848. Whaling ships from the United States, Britain, France, Germany,
31 Russia, and Hawaii hunted right whales in the Okhotsk Sea around 1845. Between 1840
32 and 1969, about 15,000 right whales were killed in the North Pacific.
33

34 **Sei Whales**

35
36 Between 1963 and 1974, whalers killed about 40,547 sei whales in the North Pacific
37 Ocean (see Table 5.6). Between 1960 and 1967, whalers killed about 5,000 sei whales in
38 the northern Gulf of Alaska (Tilman 1977).
39

40 **Sperm Whales**

41
42 Sperm whales were hunted commercially in the North Pacific Ocean from the early
43 1900s to the early 1980s. In the early 1970s, whalers killed between 8,000 and 10,000
44 sperm whales per year in the North Pacific. From 1979 to 1980, the IWC set the quota
45 for sperm whales at 2,700 animals in the North Pacific. Before this modern period
46 whaling ended, about 210,000 sperm whales had been killed in the North Pacific Ocean.
47 About 26,000 of these whales were killed in the Bering Sea (unpublished data from IWC
48 cited in NRC 1996).
49

1 **5.4.3 Aggregate Known Mortality of Steller Sea Lions in Alaska**

2
3 The western stock of Steller sea lions declined at an unprecedented rate of over 15% per year during the
4 1980s. However, between 1991 and 2000, the population declined at an annual rate of approximately 4%
5 per year. The observed rate of decline of this sea lion population in the 1980s has been attributed to
6 several factors, including mortality incidental to commercial fishing, the effects of a major regime shift in
7 the North Pacific, predation, harvests by subsistence hunters, and competition with commercial fisheries.
8 Other factors, such as disease or pollutants, while not entirely excluded as contributing factors, have been
9 considered of lesser importance in explaining the observed pattern of declines. The following is an
10 attempt to bring together all of the estimated mortalities of Steller sea lions and a synthesis of the
11 significance of those takes.

12
13 Perez and Loughlin (1991) conclude that “the high catch of northern sea lions during the 1970s by
14 foreign fisheries may partially account for the reported decline of their populations in the Aleutian
15 Islands region and the western GOA at that time, but except for 1982-84 Shelikof Strait fishery,
16 incidental catch in recent years by JV fisheries is low and does not explain the present continuing
17 decline.” Further, Merrick et. al. (1987) dismissed the commercial harvest as a reason for the overall
18 decline but suggested that local declines may have been affected by the pup harvests. Trites and Larkin
19 (1992) suggested that shooting could have also had local population effects. Another source of mortality
20 that has not been estimated is the take of Steller sea lions for bait in the crab fisheries in the early 1970s.
21 Combined with other incidental take, this may have had an effect in the population declines in the late
22 1970s and 1980s (Loughlin, pers. comm.)

23
24 By themselves, each of the reported takes would have had much less of an effect on the Steller sea lion
25 population. However, when taken together in time and location, a case can be made for significant
26 effects as a result of the pup harvest, shooting, and incidental take in the early years of the decline in the
27 eastern Aleutians and western GOA. By 1990, most of these takes had been discontinued. Mortality
28 incidental to commercial fisheries since 1990 has been estimated to be less than 50 animals per year.
29 Therefore, the contribution of incidental mortality to the current rate of decline is considered negligible.
30 Regarding the major regime shift which is thought to have begun in the late 1970s, there is current
31 evidence that this condition has remained relatively unchanged at least through most of the 1990s. Data
32 are not currently available to assess the impact of predation (e.g., killer whales) on the western
33 population of Steller sea lions in either 1980s or 1990s, other than to conclude killer whale predation
34 could have been a contributing factor in both time periods (although there is no evidence to suggest that
35 there has been a change in predation patterns in the last two decades). Finally, the most recent
36 subsistence harvest data indicates that annual harvest levels are less than 1% per year and are more likely
37 to be less than 0.5% per year. Therefore, removals due to subsistence harvest is not thought to be a
38 primary factor in the current decline.

39
40 **5.5 Impacts of Commercial Fisheries Within the Action Area**

41
42 The BSAI and GOA contain some of the most productive waters on earth. The continental shelf in the
43 eastern Bering Sea is broad and supports large, standing stocks of groundfish. The GOA has a much
44 narrower shelf and supports a smaller standing stock. Since the 1950s, a complex international fishery
45 harvests numerous species; most of the fish harvested in this region are groundfish. The Bering Sea
46 supports about 300 species of fish, most of which live on or near the bottom. About 24 of these species
47 support commercial fisheries in the BSAI.

48
49 Commercial fisheries in the action area have gone through many cycles of development and collapse

1 since they began in the 1800s and the focus of the fisheries has shifted many times since its beginning.
2 This section is organized in three primary time intervals: the 1800s to 1950s, the 1950s to 1970, and 1970
3 to the present.
4

5 **5.5.1 Impacts of early commercial fisheries from the 1800s to the 1950s**

6
7 The first small-scale fishing enterprise began in 1785 at the Karluk River on Kodiak Island to provide
8 dried salmon to the Russian fur traders. Some export of salted salmon began in the early 1800s when the
9 Russian American Company shipped small quantities of salted salmon to St. Petersburg, Russia. The
10 commercial potential of the abundant Alaska salmon resource was not realized until the 1860s when a
11 technique for large-scale canning of salmon was developed. The first salmon cannery on the Pacific
12 Coast was opened in California in 1864, and salmon canneries were built in Alaska for the first time in
13 1878. The salmon fishery in the Bering Sea began in the late 1800s with harvests from the western
14 region dominating from 1878 to 1910. Prior to Alaska statehood, management of the salmon fishery was
15 inadequate to protect salmon stock and many stocks were overfished as a result.
16

17 Pacific cod supported the first groundfish fishery in the Bering Sea. The first reported commercial
18 groundfish fishery did not begin until 1864. The cod was harvested in 1864 as part of an exploratory
19 fishery involving a single schooner. Starting in 1882, they were taken by a fleet operating from ports in
20 Washington, California, and from shore stations in the Aleutian Islands (Bakkala et al. 1981). During this
21 early fishery, the fleet consisted of schooners and the gear consisted of handlines from one-man dories.
22

23 Except for Pacific cod, and to a lesser extent sablefish, groundfish generally were ignored for targeted
24 fisheries in the late 1800s and early 1900s. Market demand, and the ability to transport fish products
25 from remote locations in Alaska to the market at reasonable cost, determined whether a fishery for a
26 species would develop; not the abundance or availability of the species to fishermen. Hence, most
27 groundfish, except for cod and halibut, were discarded or used for bait. For example, pollock was
28 considered an excellent bait fish for cod.
29

30 The groundfish fisheries were small in scale and used hook and line gear either as hand lines or setlines
31 (long anchored lines with hooks attached at intervals). Stationary gill net gear was introduced in the New
32 England cod fisheries in 1878 and beam trawls towed by sailing vessels appeared in the 1890s, but the
33 extent of their use in the Alaska cod fisheries is unknown. Steam power was introduced to fishing
34 vessels in the beginning of the 20th century. This power source allowed vessels to pull larger and more
35 efficient otter trawls, which relied on otter boards or doors to open the mouth of a trawl instead of a
36 beam. Beam trawl gear in the Northwest was first used in 1884. A sail-powered fishing vessel, and a
37 trade magazine in 1903 reported that an unnamed vessel was experimenting with an otter trawl in the
38 halibut fishery in British Columbia. Trawl or drag fisheries became well-established in the Northwest,
39 and presumably in Alaska, over the next 40 years.
40

41 A setline fishery for Pacific cod developed in 1867. Fisheries for halibut, sablefish, and groundfish
42 developed later. Regular annual landings of Pacific cod caught in the Bering Sea began in 1882. This cod
43 fishery reached its peak during World War I, when estimated annual catches ranged from 12,000 to
44 14,000 mt (Bakkala et al. 1981). In 1918, the Secretary of Commerce issued an order that suspended the
45 prohibitions on landing of catches by foreign vessels in U.S. ports to encourage the importation of fish to
46 compensate for reduced food supplies caused by World War I. This order was terminated in 1921.
47 During the time the order was in effect, Japanese vessels landed 4.5 million dry-salted cod and 80 mt of
48 dried, unsalted cod. Although most of this cod was from around the Kurile Islands and Sea of Okhotsk.
49 The size of this fishery declined after 1920, their catch slowly declined, and the fishery ended in 1950

1 (Bakkala et al. 1981).

2
3 The increased catching power of trawl gear, coupled with the advent of powered refrigeration and gear
4 handling equipment, electronic navigation, and other technologies, posed a threat to the traditional
5 Alaska fisheries, especially salmon, Pacific cod, sablefish, and halibut. Eventually, though it opened
6 fisheries for lower valued groundfish species, such as flatfish and pollock, because the trawl gear allowed
7 harvesting of larger volumes of fish. This is reflected in the early regulations. The first mention of
8 trawling in Alaska fisheries regulations was for fishing operations in 1930: “The use of any trawl in
9 commercial fishing operations is prohibited, provided that this prohibition shall not apply to fishing
10 operations conducted solely for the purpose of taking shrimp” (Fredin 1987). This prohibition remained
11 in effect until 1935, when it was relaxed to allow trawl gear to take flounders, if flounder fishing with
12 trawl gear did not result in the capture, injury, or destruction of other food fish. The trawl prohibition
13 was further liberalized in 1939, to allow fishing for king crabs west of 150° west longitude outside of
14 Cook Inlet. Eventually, in 1942, trawls were permitted in commercial fishing for all species except
15 salmon, herring, and Dungeness crabs.

16
17 From 1933 to 1937, Japan operated a small mothership fleet in the eastern Bering Sea that harvested
18 groundfish, particularly walleye pollock and flounders off Bristol Bay, which were processed into fish
19 meal (Bakkala et al. 1981). Harvests ranged from 3,300 to 43,000 mt. The fishery ended in 1937 because
20 of declines in the price of fish meal. In 1940-1941, the Japanese returned to the eastern Bering Sea to
21 harvest yellowfin sole. During this two-year period, they harvested about 10,000 mt per year.

22
23 The United States and Canada established the International Fisheries Commission, which was later re-
24 named the International Halibut Commission (NPFMC 1978) to regulate the fishery and conduct research
25 in 1923. Overfishing by the United States and Canada, stock depletion, and environmental factors,
26 caused the catch of halibut to decline and, in 1930, a new Convention was signed that broadened the
27 Commission’s regulatory power to help rebuild halibut stocks. As part of its regulatory powers, the
28 Commission closed the halibut fishery from November 16 to February 15 annually to protect spawning
29 halibut. The treaty was renegotiated in 1937 to enhance the Commission’s regulatory power, and treaty
30 revisions in 1953 changed its name to the International Pacific Halibut Commission. These early
31 groundfish fisheries appeared to overfish other species as well (Bracken 1983). Bracken provided
32 evidence of a 55 percent decline in the catch per unit effort of sablefish and a decline in average weight
33 from 8 pounds to 6.5 pounds off Alaska between 1937 and 1944.

34
35 In 1909, a domestic commercial fishery for herring developed in Norton Sound. The highest recorded
36 catch was 7,300 mt and was taken in 1978. Development of the herring fishery in the EBS was in part
37 related to the depletion of western stocks, which resulting in closing that fishery through a bi-lateral
38 USSR-Japan agreement in 1968. Peak foreign catches of 129,000 and 145,000 mt occurred in 1969 and
39 1970. From 1975 - 1982, foreign catches have ranged from 9,000 to 25,000 mt.

40
41 Pacific halibut supported another early fishery off Alaska. Commercial fishing for halibut began in 1888.
42 Although cod fishermen reported halibut being present in the Bering Sea and GOA in the 1800s, the
43 fishery did not spread to Alaska waters until after World War I. Market demand for halibut grew as
44 experience and technology developed to ice and preserve halibut sufficiently to serve eastern and mid-
45 western markets. Increased demand for halibut inspired fishermen to explore for larger halibut resources
46 farther north. The fishery began off southeast Alaska, off the south end of Baranof Island in 1911.
47 Although cod fishermen reported Pacific halibut in the Bering Sea as early as the 1800s, halibut there
48 were not harvested commercially until 1928 (in Bakkala et al. 1981). The commercial fishery for halibut
49 began in coastal waters of Washington and British Columbia and expanded into the GOA following

1 World War I.

2 3 **5.5.2 Impacts of large scale growth of commercial fisheries from the 1950s to the 1970s**

4 5 **5.5.2.1 Fisheries in the Bering Sea/Aleutian Islands**

6
7 The groundfish fisheries in the BSAI and GOA were developed by Russian and Japanese
8 fishermen between the 1959 and 1976 (except for halibut). Prior to 1976, there was virtually no
9 domestic involvement in these fisheries.

10
11 The Soviets began commercial fishing operations off Alaska in 1959, however, no catch statistics
12 were provided until 1964 when the U.S.S.R. began to provide these data to the Food and
13 Agricultural Organization (FAO) of the United Nations. Obtaining accurate fishing mortality
14 data was a general problem of the foreign distant water fisheries off Alaska. Pruter (1976)
15 estimated that the cumulative catch of bottomfish by all nations during the period 1954-1974
16 amounted to over 22 million mt, of which Japan accounted for over 15 million mt (67 percent),
17 the USSR accounted for about 6 million mt (25 percent) and the U.S. for about 1.5 million mt (6
18 percent). The remainder of the catch was taken by other nations like South Korea, Poland, East
19 Germany, West Germany, China (Taiwan), and Canada. Historical catches of groundfish and
20 squid taken in BSAI, and GOA.

21
22 The U.S. lifted restrictions on Japanese fleets in U.S. waters in 1952. In 1954, Japanese fishing
23 fleets returned to the BSAI with 2 to 4 mothership fleets and up to three independent trawlers.
24 Until 1957, these vessels fished for yellowfin sole and other flounder off Bristol Bay (Bakkala et
25 al. 1981). From 1958 to 1963, the Japanese fleets expanded throughout the Bering Sea and
26 included sablefish, Pacific ocean perch, and herring in the fishery, although yellowfin sole was
27 still their principal focus (Bakkala et al. 1981). These catch statistics reveal the growth and
28 magnitude of the foreign groundfish harvest off Alaska during the late-1950s through the early-
29 1970s. Of particular note were the high catches of the yellowfin sole fishery in the Bering Sea,
30 which peaked in 1962, and the high catches of slope rockfish (e.g. Pacific ocean perch) in the
31 GOA during the period 1963-1968. Both of these stocks were overfished, and while yellowfin
32 sole is believed to have recovered, slope rockfish are still recovering.

33
34 From 1960 to 1962, this fishery landed between 421,000 and 554,000 mt annually. The total
35 catch in the eastern Bering Sea rose sharply in the mid- to late-1960s when large, factory trawlers
36 replaced smaller trawlers. From 1964 to the mid-1970s, the fishing power of these fleets created
37 a pattern of overfishing one species before shifting to another species. This pattern was reflected
38 in a progression of increasing catch, followed by steep declines as abundance fell off, followed
39 by another increase in catch as the fleet targeted another species or new fishing grounds. With
40 the decline of catches in the Bering Sea, the fleet moved to new areas, including the GOA.

41
42 In the early 1970s, foreign access to U.S. fishing grounds within the 12-nautical mile limit was
43 controlled through bilateral agreements with Japan, Poland, the USSR, Taiwan, and the Republic
44 of Korea. These agreements established time-area restrictions, limits on the amounts of
45 commercial species that could be harvested, and regulations restricting foreign fleets from
46 targeting certain species. The first closures were imposed to reduce the foreign catch of adult
47 and juvenile Pacific halibut. In 1973, when major groundfish stocks began to seriously decline,
48 catch quotas were negotiated between the U.S. and the principal foreign fishing nations.

1 Despite these restrictions, foreign catch levels remained high. By 1976, foreign fleets had
2 overfished several groundfish stocks including yellowfin sole (Pruter 1973) and Pacific ocean
3 perch, and had dramatically reduced the catch per unit of effort for sablefish and walleye pollock.
4 For example, between 1968 and 1973, fishing effort for walleye pollock had increased almost
5 four times while annual catch-per-unit-effort had declined by 50% and the fishery was
6 increasingly dependent on small, young fish (INPFC 1977). These high catch levels contributed
7 to the decline of other, commercially-important species like Pacific halibut (Larkins 1980).
8

9 Since 1981, the groundfish catch from the BSAI has ranged from a low of 1,294,132 mt in 1999
10 to a high of 1,996,467 mt in 1992. For the 2000 fisheries, the NPFMC adopted a total allowable
11 biological catch level of 2,260,113 mt for the BSAI. In 2000, the NPFMC set the TAC for BSAI
12 groundfish fishery at 2 million mt.
13

14 In the 1980s, foreign fleets fishing in the U.S. EEZ were replaced by joint venture fisheries. By
15 1988, the U.S. fleet was catching the walleye pollock in the eastern Bering Sea and delivering it
16 to foreign vessels through joint-venture fisheries that were set up after the U.S. declared the 200-
17 mile EEZ (Bakkala 1993). By 1995, the groundfish fleet was comprised of 1,545 vessels
18 including 1,159 vessels fishing with hook and line gear, 263 with pots, and 264 with trawls, with
19 some of the vessels using more than one gear type. Of the total number of vessels, about 120
20 were catcher processors. The groundfish fleet came mainly from communities in Alaska,
21 Washington, and Oregon. Their total groundfish harvest in 1995 was approximately 2.1 million
22 mt, with 90% coming from the BSAI. The overall catch was 65% pollock, 15% Pacific cod, 12%
23 flatfish, 4% Atka mackerel, 2% rockfish, 1% sablefish, and lesser amounts of other species.
24

25 **The Pollock Fishery in the Aleutian Basin**

26
27 The pollock fishery in the Aleutian Basin (the Donut Hole) developed rapidly in the
28 1980s. The uncontrolled growth of this fishery spurred worries about overfishing and
29 the effects of Aleutian Basin catches on the pollock populations of the eastern Bering
30 Sea. The donut hole fishery was being conducted by trawl vessels from Japan, the
31 Republic of Korea, Poland, the People's Republic of China, and the former Soviet
32 Union. Catch data submitted by these countries indicated that annual harvests in the
33 donut hole rose to about 1.5 million mt from the mid-1980s to 1989. Largely due to
34 drastic declines in catch and catch per unit effort from 1990, leading to a total catch of
35 under 300,000 mt in 1991 and under 11,000 mt in 1992, the governments agreed to
36 suspend fishing in the area for 1993 and 1994. The results of monitoring in the region
37 during this 2-year hiatus produced no evidence that the stock recovered.
38

39 As a result, and after three years of negotiations, the Convention on the Conservation and
40 Management of Pollock Resources in the Central Bering Sea was signed on December 8,
41 1995. The major principles of this convention included: no fishing in the donut hole
42 unless the biomass of the Aleutian Basin exceeds a threshold of 1.67 million mt;
43 allocation procedures; 100 percent observer and satellite transmitter coverage; and prior
44 notification of entry into the donut hole and of transshipment activities.
45

46 From 1997 to 2000, the Parties to the Convention established the Allowable Harvest
47 Level of pollock in the Central Bering Sea at zero, although the Parties agreed that there
48 were insufficient data to directly estimate the pollock biomass in the Aleutian Basin.
49 Nevertheless, in 1998 the best estimate placed this biomass at 342,000 mt, which was

1 about 50 percent lower than the 1997 estimate and the lowest biomass on record for this
2 area. In 1998, the biomass in the entire Aleutian Basin was estimated at 572,000 mt;
3 estimates for 1999 and 2000 showed no increase in biomass. In addition, all trial fishing
4 results in 1997 showed little or no pollock in the Central Bering Sea.

5 6 **Fisheries for Crab and Shellfish**

7
8 In 1930, Japan began commercial harvests of king crab, although final development of
9 the fishery was delayed by World War II. U.S. fleets began to harvest king crab in 1947
10 followed by a resumption of the Japanese fishery for king crab in 1953. In 1959, Russian
11 fleets entered the king crab fishery. By 1964, the catch of king crab peaked with
12 9,000,000 crabs, then declined to 3,500,000 in 1970 when Russia ended their harvest.
13 The Japanese terminated their fishery in 1974. By 1975, the entire harvest of 9,000,000
14 was taken by U.S. fishermen (Lowry et al. 1982).

15
16 Prior to 1964, eastern Bering Sea tanner crab were harvested incidental to the king crab
17 fishery. Landings peaked at over 24 million crabs in 1969 and 1970. Russian terminated
18 their involvement in the fishery in 1971. By 1976, the harvest of 18 million tanner crabs
19 was divided between the U.S. and Japanese fishermen.

20
21 Fishing for shrimp in the Bering Sea began in 1961 and involved Japanese and Russian
22 trawlers. The fishery reached its highest levels in the early 1960s, then declined to
23 negligible levels by 1972 (Lowry et al. 1982).

24 25 **5.5.2.2 Fisheries in the GOA**

26 27 **Fisheries for Halibut and Salmon**

28
29 During the late 1950s and 1960s, halibut and salmon dominated the U.S. domestic
30 fishery in Alaska. The catch of groundfish in the northeast Pacific by domestic fisheries
31 was minor compared with foreign harvests and amounted to less than 100 tonnes
32 (Forrester et al. 1978). The halibut fishery, which began to rebuild under the guidance of
33 the International Halibut Commission, reached an all-time high of 24,000 mt in 1962.
34 High annual catches continued until 1966, when catches began to decline again. By
35 1974, halibut landings declined to 7,300 mt, most of which came from central GOA. For
36 the 20 year period from 1955 to 1975, between 65 and 80 percent of the total halibut
37 landed came from the GOA.

38 39 **Fisheries for Pacific Ocean Perch**

40
41 Japanese and Russian vessels began fishing the GOA in the early 1960s and targeted
42 Pacific ocean perch (Alton 1981). This fishery expanded rapidly, resulting in annual
43 catches that peaked at 380,000 tonnes in 1965-1966. By the end of that period, Pacific
44 ocean perch had been overfished. The stock experienced a sharp decline in abundance
45 and during that period, the density of Pacific ocean perch declined by 93% (Alton 1981).
46 With the decline of the Pacific ocean perch, foreign fleets shifted their target to walleye
47 pollock (Alton 1981). When Japan developed a method for producing surimi from
48 pollock on-board, the Japanese fishery shifted to walleye pollock and production grew
49 from 175,000 tonnes in 1964 to 1.9 million tonnes in 1972.

1 In 1962, Russian vessels began fishing the GOA and targeted Pacific ocean perch (Alton
2 1981). The following year, a smaller Japanese fleet entered the GOA and fished for
3 Pacific ocean perch and sablefish. This fishery expanded rapidly, resulting in annual
4 catches that peaked at 380,000 tonnes in 1965-1966. By the end of that period, Pacific
5 ocean perch had been overfished and the stock experienced a sharp decline in
6 abundance; during that period, the density of Pacific ocean perch declined by 93%
7 (Alton 1981). The perch fishery peaked in 1965 and has since declined to about 48,000
8 mt.

9
10 With the decline of the Pacific ocean perch, foreign fleets shifted their target to walleye
11 pollock (Alton 1981). When Japan developed a method for producing surimi from
12 pollock on-board, the Japanese fishery shifted to walleye pollock and production grew
13 from 175,000 tonnes in 1964 to 1.9 million tonnes in 1972. The Republic of Korea
14 entered the groundfish fishery in the GOA in 1972, five years after their entry in the
15 Bering Sea. They began by longlining for sablefish, but also had substantial trawl
16 operations. Poland conducted small fisheries in the GOA in 1974 and 1975, taking 2,000
17 mt of pollock, Atka mackerel, and rockfish.

18
19 As noted in the discussion on the development of groundfish fisheries in the Bering Sea (see the
20 preceding section), in the early 1970s, foreign access to U.S. fishing grounds within the 12-
21 nautical mile limit was controlled through bilateral agreements with Japan, Poland, the USSR,
22 Taiwan, and the Republic of Korea. When major groundfish stocks began to decline in the early
23 1970s, catch quotas were negotiated between the U.S. and the principal foreign fishing nations,
24 but foreign fleets still overfished several groundfish stocks, including yellowfin sole and Pacific
25 ocean perch and had dramatically reduced the catch per unit of effort for sablefish and walleye
26 pollock (see Table 5.8).

27
28 Since 1986, the total groundfish catch in the GOA has ranged from a low of 146,703 mt (in
29 1987) to a high of 261,694 mt (in 1992). In 1999, total groundfish catch was 227,044 mt. All of
30 these catches have been well below the 800,000 mt optimal yield cap. The catches reflect recent
31 biomass trends and a conservative harvesting strategy.

32 33 **5.5.3 Impacts of commercial fisheries within the action area from the 1970s to the present**

34
35 In the early 1960s, the U.S. had fisheries authority only to 3 miles and those waters were closed to all
36 foreign fishing beginning in 1964. The U.S. thus had little leverage to restrict the large offshore Japanese
37 and Soviet operations during their initial build-up. Fisheries research and information exchange were
38 conducted initially with Japan and Canada under the auspices of the International North Pacific Fisheries
39 Commission (INPFC), but it focused mainly on salmon interception issues beginning with its first
40 organizational meeting in 1954. The Japanese provided some catch data, but the Soviets, fishing on five-
41 year plans, provided very little information on their harvests.

42
43 The U.S. fisheries extended their jurisdiction from 3 to 12 miles on October 4, 1966 (P.L. 89-658). It
44 provided for continued foreign fishing in the 9-mile contiguous zone, but significantly increased U.S.
45 leverage in controlling those fisheries. For example, INPFC first considered joint studies of groundfish
46 (other than halibut) such as Pacific ocean perch and sablefish in 1967-1971. It produced no joint
47 conservation recommendations for either species even though it was well recognized that both stocks
48 were in jeopardy. The INPFC and the U.S.- Canada International Pacific Halibut Commission began a
49 joint monitoring program for halibut bycatch in Japanese trawlers in the eastern Bering Sea in 1972.

1 U.S.-foreign bilateral agreements were the main mechanism for managing the foreign fisheries.
2 Bilaterals were negotiated in protracted sessions, beginning in 1967 with Japan and the USSR (there was
3 a king crab bilateral with the Soviets in 1965). The first one was negotiated for groundfish with the
4 Soviets in February 1967. The early bilaterals focused on protecting domestic crab, halibut and shrimp
5 fisheries from gear conflicts and grounds preemption by foreign trawlers, and protecting fur seal
6 populations in the Pribilof Islands.
7

8 Groundfish management was addressed beginning in 1972-1973. By then, foreign operations had
9 depressed stocks off Alaska. Catches of yellowfin sole in the eastern Bering Sea, for example, had
10 fallen sharply following very large removals by Japan and the Soviet Union. Pacific ocean perch stocks
11 were decimated. Pollock catches were increasing rapidly, and were thought likely to follow the same
12 pattern as perch and flatfish.
13

14 In 1973-1974, catch quotas were placed on eastern Bering Sea pollock and flatfish, and on GOA Pacific
15 ocean perch and sablefish. Additionally, a complex array of closures was established mainly to protect
16 U.S. fisheries for crab and halibut. The catch quotas represented the average catches of the previous 3-4
17 years and were an attempt to put the fisheries on hold so the stocks could be evaluated. Unfortunately,
18 each country was responsible for monitoring its catch quotas, the only internationally acceptable
19 arrangement at the time. The final round of negotiations on bilaterals before the Act was passed
20 occurred in late 1974 with Japan and in mid-1975 with the USSR. The U.S. had negotiated an agreement
21 with ROK in 1972, effective through 1977, and with Poland in 1975.
22

23 **5.5.3.1 Preliminary fishery management plans (PFMP)**

24

25 Following the implementation of the FCMA on March 1, 1977, foreign fishing could be
26 conducted in the new 200 nautical mile Fishery Conservation Zone (later changed to Exclusive
27 Economic Zone or EEZ) only pursuant to an international treaty or a governing international
28 fishery agreement. Governing agreements were completed with Taiwan and the USSR in 1976
29 and with Japan, ROK and Poland in 1977. While these agreements provided foreign fleets access
30 to the EEZ, these fleets had to fish under the rules of PFMP that applied only to foreign fisheries.
31 Foreign fisheries off Alaska were managed under four PFMP: (1) trawl fisheries and herring
32 gillnet fishery of the eastern Bering Sea and Northeast Pacific; (2) trawl fishery of the GOA; (3)
33 sablefish fishery of the eastern Bering Sea and Northeastern Pacific; and, (4) snail fishery of the
34 eastern Bering Sea. The latter fishery was small fishery conducted by 21 Japanese vessels that
35 longlined with pots along the shelf edge of the Bering Sea northwest of the Pribilof Islands,
36 harvesting about 3,000 mt of edible meats in the mid-1970s. Snails were later incorporated as an
37 “unallocated species” in the BSAI groundfish plan published in 1981.
38

39 The PFMP recognized that the fisheries could adversely affect marine mammals through (1)
40 direct impacts from trawl netting, plastic wrapping bands and other debris around their necks or
41 bodies; and (2) indirect impacts of the fisheries competing for some of the same species of fish
42 and shellfish used as food by the northern fur seal and other marine mammals. Nevertheless, the
43 PFMPs did not contain measures to reduce potential impacts of the fisheries on marine mammals
44 and seabirds, except for restrictions on operating near the Pribilof Islands.
45

46 In summary, the PFMPs continued and enhanced provisions of the various bilateral agreements.
47 In many respects, the PFMPs established the fundamental philosophy in managing the fisheries
48 over future years as it transitioned to a completely domestic fishery in the late 1980s. The PFMPs
49 set harvest limits for the main target species and fishing ceased when those limits were reached.

1 The PFMPs required the fishermen to report catch and support observers. The PFMPs protected
2 species other than groundfish using time-area closures and prohibiting retention of species such
3 as salmon, halibut, crab, and shrimp that were important target species for domestic fisheries.
4 The PFMPs implemented time-area closures to protect domestic fishermen from grounds
5 preemption and gear conflicts caused by mobile foreign trawl gear.
6

7 **5.5.3.2 FMPs**

8 **The BSAI Area FMP**

9
10
11 In August 1981, the NPFMC finalized an FMP for groundfish fisheries in the BSAI. The
12 FMP was implemented with the 1982 fisheries. The FMP carried forward most of the
13 management measures from the PFMPs. Optimal yields were set for each of the main
14 species and species complexes and fisheries were closed when the optimal yield was
15 reached. The concept of a set-aside or reserve was introduced to provide allocations to
16 individual fisheries in-season. In the BSAI, 5% or 500 mt of each species was set aside,
17 whichever was greater, and optimal yields were distributed by management area.
18

19 The 1981 FMP specifically focused on rebuilding depleted groundfish stocks. The FMP
20 managed groundfish as a species complex, because populations of some species of
21 groundfish will increase in response to decreases in populations of other species in the
22 complex. The biomass of pollock in the eastern Bering Sea was estimated at 8.24 million
23 mt (the most abundant). In the Aleutian Islands, the most abundant biomass consisted of
24 Pacific ocean perch, pollock, and Atka mackerel. The FMP also emphasized protecting
25 prohibited species and the associated domestic fisheries. The FMP contained a ban on
26 retaining halibut in trawls and expanded time-area closures. Restrictions on bottom
27 trawls were applied to the foreign fisheries and there were depth restrictions on foreign
28 longline fishing for Pacific cod in the Winter Halibut Savings Area in the eastern Bering
29 Sea. Except for a prohibition against retaining prohibited species, the FMP placed no
30 restrictions on domestic fishermen in the Bering Sea.
31

32 Since 1981, the groundfish catch from the BSAI has ranged from a low of 1,294,132 mt
33 (1999) to a high of 1,996,467 mt (1992). In 1988, the MSY had been increased to 3.4
34 million mt. This revised estimate, combined with increased domestic use of the resource,
35 resulted in pressure to increase the 2 million metric ton cap to allow foreign and joint-
36 venture fisheries to continue. In 1988, and for several years thereafter, fishermen asked
37 the NPFMC to increase the 2 million mt cap on optimal yield in the BSAI. The NPFMC
38 rejected these proposals because of uncertainties in the rate of removal of pollock from
39 waters immediately outside of the fishery (e.g., in international waters); the amount of
40 bycatch that would result; and the reliability of scientific methodologies at that time for
41 determining allowable biological catch. For the 2000 fisheries, the NPFMC adopted an
42 ABC of 2,260,113 mt for the BSAI. In 2000, the NPFMC set the TAC for BSAI
43 groundfish fishery at 2 million mt.
44

45 Since 1981, the NPFMC has amended the FMP many times, primarily to protect target
46 species, protect prohibited species, control bycatch, balance the social and economic
47 benefits of the fishery, and increase the involvement of the domestic fleet in the
48 groundfish fisheries. The NPFMC achieved this last objective in 1987, when groundfish
49 fisheries in the BSAI became totally domestic (although joint ventures operated in the

1 BSAI until 1990).

2
3 The NPFMC has taken numerous actions to protect prohibited species – mostly red king
4 crab, tanner crab halibut, and salmon – although other species benefitted from these
5 closures. Between 1986 and 1990, the NPFMC closed areas in the eastern Bering Sea
6 (one area around the Pribilof Islands and two areas in Bristol Bay) to protect king crab
7 from domestic trawlers. The Pribilof Islands Conservation Area, Red King Crab Savings
8 Area in Bristol Bay, and a Nearshore Bristol Bay Closure Area, Bristol Bay Winter
9 Halibut Savings Area, Bristol Bay Pot Savings Area, and three Herring Savings Areas
10 (two summer and one winter) that are closed to trawling and scallop dredging to protect
11 king crab and bottom habitat. The NPFMC later established Chum Salmon Savings
12 Areas that were designed to reduce the amount of chum salmon taken as bycatch in trawl
13 fisheries. Together, these areas close about 80,000 square nautical miles to trawling and
14 scallop dredging.
15

16 In 1984 the NPFMC began to produce annual resource assessment documents that
17 contained complete descriptions of each stock and its current condition. These
18 documents set the example and standard for SAFE documents that were later required of
19 all regional fishery management councils in the U.S. In 1990, the NPFMC established a
20 comprehensive observer program (paid by industry) that would verify catch levels and
21 monitor bycatch. The NPFMC required 100% observer coverage on all vessels over 125
22 ft and 30% coverage on those between 60 and 125 ft.
23

24 Since the late 1980s, the NPFMC has taken numerous actions to protect habitat, seabirds,
25 and marine mammals. In 1988, the NPFMC approved a habitat policy and established a
26 habitat committee to review permit requests that might impact fish habitat. In 1999, the
27 NPFMC amended FMPs to include essential fish habitat (Amendment 55 to the FMP for
28 the Groundfish Fishery of the BSAI Area and Amendment 8 to the FMP for the
29 Commercial King and Tanner Crab Fisheries in the BSAI).
30

31 32 **GOA FMP**

33
34 On October 11, 1977, the NPFMC finalized the FMP for GOA groundfish fisheries,
35 which was implemented with the 1979 fisheries. The FMP continued most of the
36 management measures contained in the PMPs to protect target species, bycatch species,
37 and the associated domestic fisheries. The FMP set optimal yields for each of the main
38 species and species complexes, and fisheries were closed when the optimal yield was
39 reached. The concept of a set-aside or reserve was introduced to allow for in-season
40 flexibility in the allocation of the catch. In the GOA, the reserve was 20% of each
41 species. The principal groundfish species considered resident in the GOA included
42 walleye pollock (which the plan called Alaska pollock), Pacific cod, sablefish, Pacific
43 ocean perch, halibut, turbot, flathead sole, rock sole, and Atka mackerel. When the FMP
44 was finalized, the fishery was estimated to yield 325,700 mt. Of this total, pollock were
45 expected to represent 169,000 mt or about 52% of the yield.
46

47 This FMP also focused on rebuilding depleted groundfish stocks, managed groundfish as
48 a species complex, and protected prohibited species like Pacific halibut. The FMP
49 contained a ban on retaining halibut in trawls and expanded time-area closures.

1 Restrictions on bottom trawls were applied to the foreign fisheries. The FMP
2 implemented a Prohibited Species Catch limit for halibut for domestic trawlers for the
3 first time off Alaska. By the end of 1985, only minor foreign fisheries, directed on
4 pollock and Pacific cod, were being allowed in the GOA and pollock stocks in the Gulf
5 of Alaska-Shelikof Straits were beginning to decline rapidly. From 1986 to 1990,
6 pollock stocks in the Western and Central GOA declined significantly. The NPFMC
7 responded by setting lower harvest levels every year to protect this stock.
8

9 In 1978, the NPFMC closed the GOA east of 140° W to all foreign longlining. The
10 NPFMC prohibited foreign longlining inside of the 500 meter isobath, except that a
11 longline fishery directed at Pacific cod could be conducted landward of the 500 meter
12 isobath west of 157° W longitude (NPFMC 1978). The NPFMC reduced the optimum
13 yield for sablefish to 13,000 mt for the entire GOA to encourage the sablefish stock to
14 rebuild, increase the size of fish available, and encourage a U.S. longline fishery and
15 protect halibut. In 1978, the NPFMC also proposed to distribute the optimum yield
16 through the five INPFC statistical areas in the GOA proportional to the biomass of the
17 stocks found in those area (NPFMC 1978).
18

19 Since 1981, the NPFMC has amended the FMP many times, primarily to protect target
20 species, protect prohibited species, control bycatch, balance the social and economic
21 benefits of the fishery, and increase the involvement of the domestic fleet in the
22 groundfish fisheries. The NPFMC achieved this last objective in 1986, when groundfish
23 fisheries in the GOA became totally domestic (although joint ventures operated in the
24 GOA until 1988).
25

26 The NPFMC has taken numerous actions to protect prohibited species – mostly red king
27 crab, tanner crab halibut, and salmon – although other species benefitted from these
28 closures. Between 1986 and 1990, the NPFMC closed areas around Kodiak Island to
29 protect king crab from domestic trawlers. In the 1990s, the NPFMC implemented a
30 rebuilding plan for Pacific ocean perch stocks in the GOA, which had been decimated by
31 Soviet fisheries in the 1960s and have not recovered. The NPFMC later revised this
32 rebuilding plan and approved a new program called improved retention and improved
33 utilization for pollock and Pacific cod in the BSAI and for the GOA. This program was
34 intended to reduce bycatch and discard of juveniles; to achieve this outcome, the
35 program required fishermen to land all pollock and cod harvested, even juveniles and
36 other unmarketable fractions.
37

38 The NPFMC dramatically improved the amount and quality of information available to
39 manage groundfish fisheries in the GOA. After the NPFMC began to produce annual
40 resource assessment documents for the BSAI, they implemented them for the GOA. In
41 1990, the NPFMC established a comprehensive observer program (paid by industry) that
42 would verify catch levels and monitor bycatch. As in the BSAI, the NPFMC required
43 100% observer coverage on all vessels over 125 ft and 30% coverage on those between
44 60 and 125 ft.
45

46 **5.5.3.3 Amendments to the FMPs to mitigate fisheries impacts**

47

48 **Amendments to the BSAI FMP to mitigate fisheries impacts**

49

1 In 1985, the Council voted to prohibit the discard of nets and debris, which often caused
2 entanglement and mortality with marine mammals and other sea life. Between 1986 and
3 1990, the NPFMC voted against raising the BSAI 2 million mt cap on groundfish,
4 partially in deference to ecosystem impact concerns. In 1991, NMFS listed Steller sea
5 lions as threatened and banned shooting near their rookeries and haulouts, reduced levels
6 of incidental take, and implemented a 3-mile buffer zones around principle sea lion
7 rookeries.

8
9 NMFS closed areas year-round to trawling within 10 miles of 37 Steller sea lion
10 rookeries and to within 20 miles during the pollock A season (January 20-April 15)
11 around five rookeries in the BSAI with comparable closures in the GOA in 1991. To
12 reduce competition for prey and avoid localized depletion, the pollock TAC was spread
13 over three areas, and limits were placed on the amount of excess pollock that could be
14 taken in a quarter.

15
16 On July 13, 1993, NMFS issued regulations (BSAI FMP amendment 28) that subdivided
17 the Aleutian Islands subdistrict into three subareas (Areas 541, 542, 543) because of
18 concerns that the concentration of fishery removals, particularly Atka mackerel, in the
19 eastern Aleutian Islands that occurred in recent years could cause localized depletion of
20 groundfish stocks (58 FR 37660). Although this measure was designed to disperse the
21 Atka mackerel TAC and conserve the mackerel stock, it was also considered beneficial
22 to Steller sea lions.

23
24 In 1998, NMFS issued regulations for Amendments 36/39 to the BSAI and GOA FMPs
25 (63 FR 13009), which created a forage fish species category in both FMPs and
26 implemented management measures for these species. These amendments prohibited
27 directed fishing for forage fish at all times in Federal waters of the BSAI and GOA to
28 prevent the development of a commercial directed fishery for forage fish, which are a
29 critical food source for many marine mammal, seabird, and fish species. The
30 amendments recognized that many species of marine mammals and seabirds in the BSAI
31 and GOA had declined and that decreases in the forage fish biomass could contribute to
32 further declines of these species.

33
34 In 1998, the NPFMC recommended changes to the Atka mackerel fishery. The fishery
35 occurs almost exclusively in the Aleutian Islands region west of 170°W and south of
36 55°N (Figs. 2.4 or 4.7). This region (within the US EEZ) consists of 1,001,780 km² of
37 ocean surface, of which 104,820 km² is Steller sea lion critical habitat (approximately 10
38 percent). The purpose of the recommended changes was to reduce the potential for
39 competition between the Atka mackerel fishery and Steller sea lions. The evidence for
40 such competition was based on catch-per-unit-effort data from various locations in the
41 Aleutian Islands. The data suggested that local harvest rates were much larger than the
42 overall target rates for the entire Aleutian Island region. Since most of the mackerel
43 catch came from Steller sea lion critical habitat (about 80% in 1995-97), the evidence for
44 locally high harvest rates raised concerns that the fishery might be depleting local prey
45 availability in areas considered critical for sea lion recovery.

46
47 The changes implemented in 1999 split the Atka mackerel fishery into two equal (by
48 TAC) seasons and imposed spatial restrictions on the distribution of the fishery. The
49 spatial measures reduced the allowable catch in critical habitat from about 80% to levels

1 at or below 40% over the period from 1999 to 2002. Prior to 1999, a total of 17,120 km²
2 (16%) of Aleutian Island critical habitat was closed to all trawl fisheries year round (10-
3 nm trawl exclusion zones around important rookeries and haulouts). As a result of the
4 Atka mackerel measures implemented in 1999, an additional 4,600 km² (an additional
5 4% of critical habitat) was closed to all trawl fisheries from January-April each year
6 (between 10 and 20 nm around the rookeries on Seguam and Agligadak Islands).
7

8 **BSAI pollock measures and the 1998 jeopardy Biological Opinion**

9

10 On December 3, 1998, a biological opinion was issued on three fisheries proposed for
11 1999 through 2002 by NMFS: (1) the authorization of an Atka mackerel fishery from
12 1999 to 2002 under the Groundfish FMP of the BSAI; 2) the authorization of the
13 pollock fishery from 1999 to 2002 under the Groundfish FMP of the BSAI; and 3) the
14 authorization of the pollock fishery from 1999 to 2002 under the Groundfish FMP
15 Management Plan of the GOA. The opinion concluded that the Atka mackerel fishery
16 was not likely to jeopardize the western population of Steller sea lions or adversely
17 modify its critical habitat. However, the opinion also concluded that the pollock
18 fisheries, as proposed for 1999 to 2002, were likely to jeopardize the endangered western
19 population of Steller sea lions and destroy or adversely modify their critical habitat. The
20 opinion did not prescribe an entire set of reasonable and prudent alternatives (RPAs) for
21 the two pollock fisheries, but rather established a framework to avoid the likelihood of
22 jeopardizing the continued existence of Steller sea lions or adversely modifying their
23 critical habitat. This framework included guidelines (ranging from specific to general)
24 for management measures to achieve three principles: 1) protection of waters adjacent to
25 rookeries and haulouts, 2) temporal dispersion of the pollock fisheries, and 3) spatial
26 dispersion of the fisheries. These three principles, in combination, were intended to
27 modify the fisheries to avoid jeopardy and adverse modification.
28

29 On December 13, 1998, the NPFMC recommended a set of revised management
30 measures for the pollock fisheries based on these RPA principles to avoid jeopardy and
31 adverse modification. On December 16, those measures were incorporated (with some
32 modification) into the December 3rd opinion and, on January 22, 1999, the measures were
33 published in an emergency rule for the 1999 pollock fisheries. The emergency rule was
34 extended until July 19, 1999. Therefore, at its June 1999 meeting, the NPFMC made
35 further recommendations for the later half of 1999 (extension of the emergency rule) and
36 for 2000 and beyond (permanent rule).
37

38 The NPFMC measures were developed to 1) avoid competition during the early winter
39 season and around rookeries and major haulouts by closing that period and those areas to
40 pollock trawling, 2) disperse the fisheries spatially, and 3) disperse the fisheries
41 temporally. In addition, the Aleutian Islands region was closed to pollock fishing
42 (22,000 mt were caught in the Aleutian Island region in 1998; slightly more than 2% of
43 the BSAI pollock catch). After the measures were implemented, a total of 210,350 km²
44 (54%) of critical habitat was closed to the pollock fishery (BSAI and GOA combined).
45 The portion of critical habitat that remained open to the pollock fishery consisted
46 primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA and
47 parts of the eastern Bering Sea special foraging area.
48

49 In the eastern Bering Sea shelf, both the catches of pollock and the proportion of the total

1 catch caught in critical habitat have been reduced significantly since 1998 as a result of
2 the NPFMC actions:
3
4

5 **Estimated pollock catches (mt) and percent caught in the Sea Lion Conservation**
6 **Area in the eastern Bering Sea**

7

8 Months	1998	1999	2000
9 January-March	441,000 (88%)	222,300 (57%)	156,800 (39%)
10 January-December	642,100 (60%)	372,800 (39%)	

11

12 The NPFMC measures taken to implement the RPAs also accomplished some spatial and
13 temporal spreading of the pollock fishery in the eastern Bering Sea (Figs. 5.1 and 5.2).
14 Prior to the measures (1998), the fishery was concentrated into 2 seasons, each
15 approximately 6 weeks in length in January-February and September-October (Fig. 5.2).
16 Ninety-four percent of the pollock catch was taken in these four months (45% in
17 January-February and 49% in September-October). In 1998, the pollock fisheries
18 occurred in the Aleutian Islands (1,001,780 km² inside the EEZ), the eastern Bering Sea
19 (968,600 km²), and the GOA (1,156,100 km²). The marine portion of Steller sea lion
20 critical habitat in Alaska west of 150°W encompasses 386,770 km² of ocean surface, or
21 12% of the fishery management regions.

22 In 1999, the fishery was dispersed into March (reducing the percent taken in February)
23 and into August. Little pollock was taken in April-July. Thus, the 1999 fishery was
24 dispersed only slightly better than the 1998 fishery (Figs. 5.1 and 5.2). In 1998, daily
25 catch rates averaged over 8,100 mt/day, and peaked at over 21,300 mt/day (Fig. 5.3). In
26 1999 and 2000, average daily catch rates for January-March declined about 22% to 6,200
27 mt/day and 6,400 mt/day, respectively; daily maximums were 15,400 mt/day and 12,500
28 mt/day, respectively. These changes resulted from a combination of the RPAs and the
29 implementation of cooperatives under the AFA (see below).
30

31 For both the pollock and Atka mackerel fisheries, ABC and TAC levels were unchanged.
32 The underlying assumption of the 1998 Biological Opinion was that the total amount of
33 the catch was not an issue; rather, certain periods (early winter) and areas (around
34 rookeries and major haulouts) were protected from competition, and the catch was
35 otherwise dispersed temporally and spatially.
36

37 On October 15, 1999, NMFS issued a revised set of RPAs which NMFS implemented by
38 regulations for the 2000 fishing year. These revised RPAs and their effects on listed
39 species and designated critical habitat, will be evaluated in section 6.
40

41 **Amendments to the GOA FMP to mitigate fisheries impacts**
42

43 Since the late 1980s, the NPFMC has taken numerous actions to protect habitat, seabirds,
44 and marine mammals. In 1988, the NPFMC approved a habitat policy and established a
45 habitat committee to review permit requests that might impact fish habitat. In 1985, the
46 Council voted to prohibit the discard of nets and debris, which often caused

1 entanglement and mortality with marine mammals and other sea life. In 1991, NMFS
2 listed Steller sea lions as threatened and banned shooting near their rookeries and
3 haulouts, reduced levels of incidental take, and implemented a 3-mile buffer zones
4 around principle sea lion rookeries.
5

6 In the mid-1990s, the NPFMC chartered an Ecosystem Committee to evaluate methods
7 for formally addressing ecosystem concerns in Council deliberations. The NPFMC also
8 expanded membership of its GOA and BSAI Groundfish Management Plan Teams to
9 include marine mammal and seabird experts to provide scientific advice on annual TACs
10 and management actions that decrease the probability and magnitude of adverse effects
11 on marine mammals, seabirds, and habitat.
12

13 NMFS has closed areas year-round to trawling within 10 miles of Steller sea lion
14 rookeries in the GOA that were comparable to closures established in the BSAI during
15 the pollock A season (January 20-April 15) in 1991. To reduce competition for prey and
16 avoid localized depletion, the pollock TAC was spread over three areas, and limits were
17 placed on the amount of excess pollock that could be taken in a quarter.
18

19 In 1998, NMFS changed the seasonal apportionment of the pollock TAC in the western
20 and central GOA by moving 10% of the TAC from the 3rd fishing season (which starts on
21 September 1) to the 2nd fishing season (which starts on June 1) to reduce the potential
22 effect of pollock fishing during the fall and winter months, a period that is critical to
23 Steller sea lions (63 FR 31939). The NPFMC took this action because of concerns about
24 the importance of the fall and winter to Steller sea lions, particularly lactating females
25 and newly-weaned juveniles. In 1999, the NPFMC amended FMPs to include essential
26 fish habitat (Amendment 55 to the FMP for the Groundfish Fishery of the GOA Area).
27

28 **GOA pollock measures and the 1998 jeopardy Biological Opinion**

29
30 The potential effects of the GOA pollock fisheries were addressed in the December 3,
31 1998 Biological Opinion. The opinion concluded that the GOA groundfish fisheries, as
32 proposed in 1998, were likely to jeopardize the continued survival of the western
33 population of Steller sea lions and adversely modify its critical habitat.
34

35 For the GOA, the RPAs were intended to disperse the pollock fishery temporally into
36 four discrete seasons dispersed through the period from January 20 to November 1. For
37 1999, little temporal dispersion was accomplished (Figs. 5.4 and 5.5). For 2000, these
38 four seasons were to begin January 20, March 15, August 20, and October 1. The catch
39 was dispersed accordingly. However, the fleet capacity in the GOA exceeds that
40 required to take the catch in this area, and as a consequence, the catch was effectively
41 dispersed into four discrete pulses.
42

43 For the GOA pollock fishery, the RPAs were intended to achieve two objectives with
44 respect to spatial dispersion. The first was to reduce pollock catches from around
45 significant rookeries and haulouts by requiring that fishing occur 10 nm away from these
46 areas, and the second was to distribute the seasonal catches according to the seasonal
47 pollock biomass distributions by area. In the GOA, survey and fishery data suggested
48 that winter pollock fishing effort could be higher in Shelikof Strait (part of critical
49 habitat) than had previously been observed. Surveys indicated that as much as 50% of

1 the exploitable biomass of pollock in the GOA was inside Shelikof Strait in March, yet
 2 the recent pre-RPA winter GOA fishery did not catch 50% of its pollock from that area.
 3 Instead, the fishery worked principally in other parts of critical habitat, presumably with
 4 less available biomass, but with other advantages (e.g., closer to ports). Therefore,
 5 fishing effort may have been disproportionately large in some portions of critical habitat
 6 and considerably lower in others (e.g., Shelikof Strait). To distribute the pollock catch
 7 according to the pollock distribution, the NPFMC established a separate Shelikof Strait
 8 management area (combined areas 621 and 631) and allocated approximately 50% of the
 9 A and B season quotas to it. This essentially shifted effort from one part of critical
 10 habitat to another to more closely match the winter biomass distribution. Because of
 11 this, pollock catches from critical habitat in the A and B seasons would not be expected
 12 to decline as a result of the RPAs. During the C and D seasons, the RPAs allocated
 13 TAC by fishery management area.

14
 15 Pollock catches and the percent of catch removed from critical habitat in the GOA
 16 increased in 1999 and 2000 relative to 1998 (see below). Pollock catches during
 17 January-March from critical habitat have increased from almost 20,000 to over 34,000
 18 mt, and the proportion caught in critical habitat increased from 70% to 97%. As stated
 19 above, this is not a surprising result since the Shelikof Strait area (critical habitat) was
 20 allocated over half of the GOA pollock TAC during the A and B seasons.
 21

Estimated Pollock Catches (mt) and Percent Caught in the Steller Sea Lion Critical Habitat in the GOA			
Months	1998	1999	2000
January-March	19,900 (70%)	31,700 (88%)	34,100 (97%)
January-December	99,700 (79%)	75,600 (82%)	

22
 23
 24
 25
 26
 27 Contrary to the EBS, the GOA pollock fishery has generally become increasingly
 28 concentrated in smaller areas within Steller sea lion critical habitat (Fig. 5.4). Some of
 29 this may be attributable to decreases in total catch between 1998 (125,400 mt) and 1999-
 30 2000 (100,000 mt in both years).
 31

32 On October 15, 1999, NMFS issued a revised set of RPAs which NMFS implemented by
 33 regulations for the 2000 fishing year. These revised RPAs and their effects on listed
 34 species and designated critical habitat, are evaluated in section 6.
 35

36 **5.5.3.4 Amendments to the FMPs to conserve salmon**

37
 38 Bycatch of salmon by groundfish fisheries in the Bering Sea and the GOA has been an important
 39 issue in fisheries management for decades. Chinook salmon are caught incidentally in trawl
 40 fisheries in the BSAI and GOA, particularly in the BSAI midwater pollock fishery. Salmon are a
 41 prohibited species in the BSAI groundfish fisheries. They cannot be retained, and must be
 42 returned to the sea as soon as possible with a minimum of injury after they have been counted by
 43 a NMFS observer. However, the mortality rate for salmon caught in trawl fisheries is 100
 44 percent as salmon do not survive interception by trawl gear.
 45

1 Chinook salmon bycatch in trawl fisheries reached a high in 1980, when foreign trawl vessels
2 intercepted approximately 115,000 chinook salmon. Following Federal action to reduce bycatch
3 in the trawl fisheries, the foreign fleet was constrained by a bycatch reduction schedule that
4 reduced the allowable level each year from 65,000 chinook salmon in 1981, to 16,500 chinook
5 salmon by 1986. Domestic vessels began fishing in the mid-1980s and bycatch numbers
6 remained below 40,000 fish until 1993. From 1994-1998, most of the chinook salmon bycatch in
7 the BSAI was within the area designated as the Chinook Salmon Savings Area (CSSA) (Table
8 5.9a). During this same period, the bycatch limit of 48,000 chinook salmon was exceeded four
9 times, with a high of about 63,000 chinook salmon intercepted in 1998. Since 1996, a PSC limit
10 of 48,000 chinook salmon has been in place during the period from January 1 until April 15 for
11 vessels using trawl gear, with no restrictions on the amount of chinook salmon bycatch in the
12 subsequent months. Historically, most of the chinook salmon taken as bycatch has been by
13 pelagic trawl gear for pollock.

14
15 Although the groundfish fisheries are prohibited from retaining any salmon they catch, about
16 60,000 chinook salmon were taken incidentally in the BSAI each year between 1996 and 1998 in
17 trawl fisheries. In that same period, about 60,000 to 80,000 other salmon (mostly chum salmon)
18 were estimated as trawl bycatch annually. Most of the salmon bycatch has been taken by vessels
19 using pelagic trawl gear targeting pollock. In the Bering Sea, a limit of 48,000 chinook salmon
20 between January 1 and April 15 was established for trawl gear in the CSSA (November 29,
21 1995; 60 FR 61215).

22
23 In the BSAI, bycatch of other salmon has ranged from about 22,000 in 1995 to 78,000 in 1996.
24 Again, the vast majority of the salmon were caught in trawl fisheries. In Table 5.10, the “other”
25 salmon category is broken out by percentages of the salmon that were identified within this
26 category. No “other” salmon were caught in either the jig or pot gear fisheries. Chum salmon
27 comprise the majority of the catch, 98 percent in trawl fisheries and about 92 percent in hook-
28 and-line fisheries. Coho salmon are the next largest component, about 1.5 percent in trawl
29 fisheries and 6.5 percent in hook-and-line. About 1.4 percent are pink salmon caught in hook-
30 and-line fisheries, and very few sockeye are intercepted and no steelhead were reported.

31
32 On July 5, 1995 (60 FR 34904) NMFS established the Chum Salmon Savings Area (CSSA) in
33 the BSAI. A limit of 42,000 non-chinook salmon is established for vessels using trawl gear
34 during August 15 through October 14 in the CVOA. If the limit is reached, trawling would be
35 prohibited within the CSSA during the remainder of the period from September 1 through
36 October 14. These existing regulations prohibit trawling in the CHSSA through April 15 of each
37 year once the bycatch limit of 48,000 chinook salmon is reached. Historically, the majority of
38 the chinook salmon bycatch was accounted for before April 15 (in the winter/spring pollock
39 trawl fisheries). Recently, chinook salmon bycatch has also been high in the fall/winter period.

40
41 In 1997, the NPFMC, started analyses that would help lower the chinook salmon bycatch limit in
42 the BSAI. This proposal, submitted by the Yukon River Drainage Fisheries Association,
43 identified the current bycatch trigger of 48,000 chinook salmon as too high to effectively reduce
44 chinook salmon bycatch. At its meeting in February 1999, the NPFMC considered this
45 information and the analysis prepared by staffs from the ADF&G and the NPFMC in support of
46 this action, and adopted Amendment 58 to the BSAI FMP to reduce chinook salmon bycatch in
47 the BSAI. Five alternatives were presented to the NPFMC for consideration. The alternative
48 adopted by the NPFMC would: (1) reduce the chinook salmon bycatch limit from 48,000 to
49 29,000 chinook salmon over a 4-year period, (2) implement year-round accounting of chinook

1 salmon bycatch for the pollock fishery, beginning on January 1 of each year, (3) revise the
2 boundaries defined by the CHSSA, and (4) set new CHSSA closure dates.
3

4 In the GOA, while PSC limits have not been established for salmon, the timing of seasonal
5 openings for pollock in the Central and Western GOA have been adjusted to avoid periods of
6 high chinook bycatch. The number of salmon taken as bycatch has been much lower in the GOA
7 than in the BSAI. The number of chinook salmon taken has ranged from about 14,000 in 1995 to
8 just over 18,000 in 1999. Nearly all of the salmon taken have been by trawl gear in the GOA.
9

10 About 3,000 and 13,000 “other” salmon have been taken in the GOA as bycatch (“other” salmon
11 is primarily chum salmon) since 1996. In 1995, a high of about 65,000 “other” salmon were
12 taken, mostly in the trawl fisheries. Again, chum salmon represent the majority of the bycatch,
13 with coho salmon second. Nearly all of the bycatch of salmon in the GOA (see Table 5.9b) is
14 intercepted in trawl fisheries, with very few salmon caught in the hook-and-line fisheries. From
15 1995 through 1999, about 88% of the trawl “other” salmon bycatch were chum, 10 percent coho,
16 1 percent sockeye, and 1.5 percent pink salmon (Table 5.10). Again, no steelhead salmon were
17 reported in the fishery.
18

19 **5.5.3.5 The American Fisheries Act of 1998** 20

21 On October 21, 1998, the President signed into law the AFA. The AFA:
22

- 23 1. Established a new allocation scheme for BSAI pollock that allocates 10 percent of the
24 BSAI pollock TAC to the CDQ Program, and after allowance for incidental catch of
25 pollock in other fisheries, allocates the remaining TAC as follows: 50 percent to vessels
26 harvesting pollock for processing by inshore processors, 40 percent to vessels harvesting
27 pollock for processing by catcher/processors, and 10 percent to vessels harvesting
28 pollock for processing by motherships.
29
- 30 2. Provided for the buyout and scrapping of nine pollock catcher/processors through a
31 combination of \$20 million in Federal appropriations and \$75 million in direct loan
32 obligations. The AFA also established a fee of six-tenths (0.6) of one cent for each
33 pound round weight of pollock harvested by catcher vessels delivering to inshore
34 processors for the purpose of repaying the \$75 million direct loan obligation.
35
- 36 3. Listed by name and/or provided qualifying criteria for those vessels and processors
37 eligible to participate in the non-CDQ portion of the BSAI pollock fishery. The AFA
38 increases the U.S. ownership requirement to 75% for vessels with US fisheries
39 endorsements and prohibited new fisheries endorsements for vessels greater than 165 ft,
40 LOA, greater than 750 gross registered tons, or with engines capable of producing
41 greater than 3,000 shaft horsepower.
42
- 43 4. Increased observer coverage and scale requirements for AFA catcher/processors.
44
- 45 5. Established limitations for the creation of fishery cooperatives in the catcher/processor,
46 mothership, and inshore industry sectors.
47
- 48 6. Required that NMFS grant individual allocations of the inshore BSAI pollock TAC to
49 inshore catcher vessel cooperatives which form around a specific inshore processor and

1 agree to deliver the bulk of their catch to that processor.
2

- 3 7. Required harvesting and processing restrictions (commonly known as "sideboards") on
4 fishermen and processors who have received exclusive harvesting or processing
5 privileges under the AFA to protect the interests of fishermen and processors who have
6 not directly benefitted from the AFA.
7
- 8 8. Established excessive share harvesting caps for BSAI pollock and directed the Council to
9 develop excessive share caps for BSAI pollock processing and for the harvesting and
10 processing of other groundfish.
11

12 Since the passage of the AFA in October 1998, the Council and NMFS have developed extensive
13 management measures to implement the requirements of the AFA. While some of the resulting
14 regulations were in place for the 1999 fisheries, the majority of the regulations were
15 implemented in 2000 through emergency regulations. NMFS is currently in the process of
16 preparing proposed rules including those regulations, although it is likely that these regulations
17 will be implemented by emergency regulations again in 2000. For example, the AFA emergency
18 regulations require the allocation of pollock TAC among fishery sectors (and within sectors
19 where necessary), among fishery areas, and among fishing seasons. The rule also establishes
20 harvest restrictions or "sideboards" on the participation of unrestricted AFA catcher/processors
21 in other BSAI groundfish fisheries and completely prohibits AFA catcher/processors fishing in
22 the GOA.
23

24 The effects of the AFA on the BSAI groundfish fisheries are largely related to ownership
25 restrictions and restrictions on the number of vessels in the fishing fleet, allocation of pollock
26 among the four sectors in Bering Sea, improving observer coverage and assessment of tons
27 caught, restrictions in other fisheries (including fisheries in the GOA) of vessels benefitting from
28 the AFA, and requirements for formation of cooperatives within sectors. These allocations have
29 altered the nature of the pollock fishery by eliminating the race for fish, and allowing for better
30 temporal dispersion of catch. The formation of cooperatives may also facilitate spatial
31 dispersion of the catch to the extent that vessels can be more deliberative about where and when
32 they fish to maximize profit. At present, no evidence suggests that the implementation of the
33 AFA will increase the likelihood of operational or biological interactions between the BSAI
34 groundfish fisheries.
35

36 As described previously, the AFA, established a new allocation scheme for BSAI pollock,
37 provided for buyout and scrapping of nine BSAI pollock catcher/processors, listed by name or
38 provide qualifying criteria for non-CDQ BSAI pollock participants, increased observer coverage
39 and scale requirements for BSAI catcher/processors, established limits on BSAI pollock fishery
40 cooperatives in the non-CDQ sectors, required individual allocations of BSAI pollock TAC to
41 inshore catcher-vessel cooperatives, required restrictions on vessels benefitting from the AFA to
42 protect vessels not participating in the AFA, and established excessive share caps.
43

44 In total, the AFA deals with rules and limits for participation in the BSAI pollock fishery, and
45 allocation of the pollock among the participants. In general, issues related to allocation of TAC
46 are resolved or managed in the NPFMC arena, where the industry and the public at large have an
47 opportunity to participate. The AFA should indirectly benefit Steller sea lions by reducing the
48 fishing power of the catcher/processor sector of the BSAI pollock fleet, reducing the rate at
49 which pollock can be taken, increasing the temporal dispersion of the fishery, and thereby

1 reducing the probability of localized depletion of pollock. The AFA also should increase the
2 amount and accuracy of fisheries data from the catcher/processor sector. Such data is essential to
3 assess the pollock stock, fishing practices, and potential effects on Steller sea lions. The effects
4 of the AFA on fisheries authorized by the groundfish FMPs will be evaluated in section 6.
5

6 **5.5.4 Impacts of Alaska State managed fisheries**

7

8 ADF&G manages fishing activity within state territorial waters (from zero to three miles, hereby referred
9 to as state waters). Additionally, the state oversees BSAI crab, salmon, and some rockfish fisheries in
10 Federal waters (EEZ) under FMPs adopted by the Council. With the exception of Alaska state fisheries
11 that have specified guideline harvest limits (GHLs) for species such as sablefish, Pacific cod, and the
12 Prince William Sound pollock fishery, ADF&G coordinates their fishery openings and in-season
13 adjustments with Federal fisheries. For example, when groundfish fishing is open in Federal waters,
14 current state regulations allow fishing to occur in state waters in what is referred to as the “parallel”
15 fishery. However, the State retains regulatory jurisdiction over fisheries within State waters.
16

17 *Where and when do state fisheries occur?* As described above, state fisheries occur inside the state
18 territorial waters from zero to three miles, which happen to lie almost entirely within Steller sea lion
19 critical habitat. Not only do these fisheries occur inside critical habitat, they are concentrated in space
20 (usually bays or river outlets) and in time (usually spawning aggregations and salmon congregating near
21 rivers for their return to spawning grounds in spring and summer). The exception to this are the crab
22 fisheries, some rockfish fisheries, and salmon catch that occur outside of state waters.
23

24 State fisheries are managed by a highly localized system of regional offices scattered throughout the
25 state. Generally, each region has separate state FMPs and is responsible for producing management
26 reports, issuing GHLs, and providing in-season management of fisheries. This is in stark contrast to the
27 Federal fishery which is composed of very large management units with relatively large harvest limits.
28 The state’s system allows for micro-management down to the bay or stream level. Closures are often
29 issued over VHF radio, and fishery openings can be as short as 20 minutes. Whereas the Federal fishery
30 uses summer and winter surveys combined with stock assessment models to assess biomass and catch
31 limits, the state employs a variety of methods of determining catch and biomass including stock
32 recruitment models, aerial surveys, escapement goals, historical fishery harvest performance, and others.
33 This next provides an overview of the fisheries, including historical catch, gear used, stock assessment
34 methods, and health of the fishery, then we discuss possible direct and indirect effects of these fisheries
35 on listed species and critical habitat.
36

37 **5.5.4.1 State groundfish fisheries**

38

39 There is a relatively long history of state management of groundfish fisheries (e.g., lingcod,
40 sablefish, rockfish, Pacific cod, flatfish) in Southeast Alaska. In addition to management of
41 fisheries in inside waters, the Federal groundfish FMP for the GOA established a joint state-
42 Federal management plan for demersal shelf rockfish (DSR) in the Eastern Regulatory Area. The
43 Council annually specifies the TAC for DSR. Under Federal oversight, ADF&G manages the
44 DSR fishery throughout the EEZ in the Eastern Regulatory Area under a state FMP adopted by
45 the Alaska Board of Fisheries (BOF).
46

47 In the western GOA, the state has established separate GHLs and seasons for the following
48 fisheries: sablefish, lingcod, Pacific cod, black rockfish (*Sebastes melanops*), and blue rockfish
49 (*S. mystinus*). The state-managed fisheries for sablefish and Pacific cod occur within state waters,

1 whereas the state has full management authority for lingcod and black and blue rockfish fisheries
2 throughout the EEZ. In the Central GOA, state-managed fisheries in state waters consist of
3 Pacific cod, sablefish, pollock in Prince William Sound (PWS), and all rockfish species in state
4 waters of PWS and lower Cook Inlet (LCI). In the western GOA, the state has full management
5 authority for lingcod and black and blue rockfish fisheries throughout the EEZ and territorial
6 waters. The cumulative impact of these state fisheries will be evaluated in section 7.
7

8 **Pacific cod**

9
10 In 1996, the BOF adopted Pacific cod FMPs for fisheries in PWS, LCI, Chignik, Kodiak,
11 and the South Alaska Peninsula. All five FMPs have some common elements that
12 include: only pot or jig gear is permitted, pot vessels are limited to no more than 60 pots,
13 jig vessels are limited to no more than five jigging machines, and exclusive area
14 registration requirements. Vessels participating in the South Alaska Peninsula and
15 Chignik areas are limited to no more than 58 feet in length. Catches are allocated to users
16 as: 85% pot and 15% jig in South Alaska Peninsula and Chignik areas, 60% pot and 40%
17 jig in PWS, and 50:50 in Kodiak and Cook Inlet areas. If target gear allocation
18 percentages are not met by late in the season, then the unattained GHL becomes
19 available to all gear types. State GHLs are set as a percentage of the Federal TAC. State
20 GHLs for PWS are set at 25% of the Federal TAC for the eastern GOA. Similarly, up to
21 25% of the central GOA TAC is allocated among Chignik (up to 8.75%), Kodiak (up to
22 12.5%) and Cook Inlet (up to 3.75%). Finally, the state GHL for the South Alaska
23 Peninsula fishery is set at 25% of the western GOA TAC. The fishery generally occurs
24 in the spring following the Federal fishery, the state Pacific cod fishery opens by
25 regulation between 7 and 14 days after the Federal fishery closes.
26

27 In 2000, ADF&G implemented a small boat fishery around Adak Island (see ADF&G
28 news release dated July 5, 2000). In state waters around Adak, vessels larger than 60'
29 were prohibited, and gear types were limited to nontrawl. Effectively, this created a state
30 fishery operating off the Federal Pacific cod TAC, which further complicates the link
31 between state and Federal fisheries. This was brought up during the 2000 September
32 Council meeting in Anchorage, when a proposal was made for a Pacific cod management
33 action to separate the BSAI Pacific cod TAC into BS and AI components. Because the
34 small boat portion of the TAC is only about 1.4%, given that Adak would now only
35 receive 1.4% of a much lesser amount (an 89% reduction from the previous allocation)
36 there was significant resistance to the proposal for the Federal fishery.
37

38 **Walleye pollock**

39
40 The PWS pollock fishery is based on a constant harvest rate strategy. Because reliable
41 estimates of biomass and natural mortality are available, the PWS pollock stock falls into
42 Tier 5 of the Federal stock assessment strategy (see section 2.4.2.3). The GHL is
43 calculated as the product of the biomass estimate, instantaneous natural mortality rate
44 (0.3) and a “safety factor” of 0.75. Biomass is estimated by bottom trawl surveys in
45 summer and hydroacoustic surveys of spawning aggregations in winter. In 1999 the BOF
46 directed the ADF&G to file an emergency regulation establishing a PWS pollock trawl
47 fishery management plan to reduce potential impacts on the endangered population of
48 Steller sea lions. The plan divides the Inside District of (PWS) into three management
49 sections. The management plan also specifies that no more than 40% of the GHL may be

1 taken from any one section. To implement this plan, ADF&G managed the fishery to
2 target 30% of the GHL from any one area. The remaining 10% of the GHL was intended
3 to insure against overharvest that could occur from an unforeseen increase in harvest rate
4 or as result of incorrect inseason haul weights. This measure was in lieu of closing two
5 Steller sea lion haulouts that were specified to be closed under the 1998 biological opinion
6 (NMFS 1998). Although pollock in the GOA are considered to be one stock, the state
7 surveys pollock in PWS separately from NMFS surveys in the GOA. However, NMFS
8 takes the PWS fishery into consideration when setting the GOA TAC. In 2000, the
9 fishery began on January 20, and was estimated to be about 1,420 mt of pollock.
10 Typically, the fishery closes by mid-February.

11 **Sablefish**

12 ADFG manages sablefish fisheries in three management areas west of 144° W longitude.
13 The PWS sablefish fishery is managed for a GHL set as the midpoint of a guideline
14 harvest range derived from the estimated size of sablefish habitat and a yield-per-unit-
15 area model. The state sets a fishing season length based on the GHL, estimated number
16 of participants, and past catch rates. Rockfish bycatch is limited to 20%. In LCI, the first
17 GHL was set in 1997 based on a five-year average harvest for the area adjusted up or
18 down annually in proportion to the Federal TAC set for the GOA. The Aleutian Islands
19 sablefish management area includes all state waters west of Scotch Cap Light (164° 44"
20 W. longitude) and south of Cape Sarichef (54° 36" N. latitude). The fishery opens and
21 closes concurrent with the Federal fishery unless closed earlier by emergency order when
22 the state GHL is attained. In the Aleutian Islands the GHL is based on a combination of
23 harvest history, fishery performance, and the Federal TAC based on NMFS surveys. In
24 1999, the GHL was set at 113 mt (250,000 lbs).

25 **Lingcod**

26 The minimum legal size of lingcod is 35" total length or 28" measured from the front of
27 the dorsal fin to the tip of the tail. The minimum legal size restriction is intended to
28 allow lingcod to spawn at least two years prior to becoming vulnerable to the fishery. In
29 the PWS Management Area, the lingcod fishery is split among two districts: the Inside
30 District and the Outside District. For each district, a GHL is established based on 75% of
31 the recent 10-year average harvest. For 1999, the GHL for the Inside District was 1.8 mt
32 (4,000 lb), and 10.2 mt (22,500 lb) was set for the Outside District. In PWS lingcod are
33 primarily caught as bycatch mainly by hook-and-line vessels. In LCI, a GHL was set at
34 15.8 mt (35,000 lb) as 50% of recent five-year harvest, and only mechanical jig and hand
35 jig (hand troll) gear may be used to target lingcod. During the open fishing season in
36 PWS and LCI, lingcod may be retained as bycatch in other directed fisheries in an
37 amount that does not exceed 20% by weight of the directed groundfish species aboard
38 the vessel.

39 In the western GOA, lingcod are taken largely incidental to other fisheries. Therefore, no
40 GHLS are set and harvests are reported to be small. In Kodiak and Chignik areas, there
41 are no gear restrictions and lingcod over the size limit may be retained during July 1 –
42 December 31. The South Alaska Peninsula represents the western range limit of the
43 species, ADFG has no specific lingcod catch regulations for that area.

1 **Rockfish**

2
3 The PWS rockfish management plan, adopted by the BOF in 1992, includes three main
4 components: (1) vessel trip limits, (2) bycatch allowance for low-level retention once the
5 directed fishery is closed, and (3) a GHL for all species. There is trip limit of 1.4 mt
6 (3,000 lb) per 5-day period to provide for a slower paced fishery. Unlike sablefish and
7 lingcod, most rockfish die when discarded at sea. Therefore, ADFG has set a 20%
8 bycatch allowance which they feel provides for retention of unavoidable bycatch of
9 rockfish while avoiding an incentive to target rockfish after the closure of the directed
10 fishery. A GHL of 68 mt (150,000 lbs) for all rockfish species is set relative to average
11 harvests sustained over time. This GHL-setting method is similar to the tier 6 approach
12 used by NMFS.
13

14 The Cook Inlet Area Rockfish Management Plan imposes a 68-mt annual pound harvest
15 cap and vessel trip limits such that a fishing vessel may not land or have onboard more
16 than a total of 0.45 mt (1,000 pounds) of all rockfish species within five consecutive
17 days. When the directed fishery is closed, bycatch limits for rockfish are set at 10%
18 (more conservative than the PWS plan above).
19

20 In the western GOA, only black and blue rockfishes are managed by the state. As in the
21 central GOA, GHLS are set from historical catch data. In the Kodiak area, separate GHLS
22 are set for seven fishing districts to disperse harvest and reduce the likelihood of
23 localized depletion. Likewise, separate GHLS were established for four fishing
24 subdistricts in the Akutan District and the Unalaska District was split into three
25 subdistricts, one of which was split further into five sections. Once the directed fishery is
26 closed in the western GOA, fishers are allowed to retain up to 5% by weight of black
27 rockfish caught incidentally in other directed fisheries.
28

29 **5.5.4.2 State herring fisheries**

30
31 Alaska's commercial herring industry began in 1878 when 30,000 pounds were prepared for
32 human consumption. By 1882, a reduction plant at Killisnoo in Chatham Strait was producing
33 30,000 gallons of herring oil annually. The herring reduction industry expanded slowly through
34 the early 20th century reaching a peak harvest of 142,000 mt in 1934 (Fig 5.6). However, as
35 Peruvian anchovetta reduction fisheries developed, Alaska herring reduction fisheries declined so
36 that by 1967 herring were no longer harvested for reduction products.

37 Substantial catches of herring for sac roe began in the 1970s as market demand increased in
38 Japan, where herring harvests had declined dramatically. Presently, herring are harvested
39 primarily for sac roe, still destined for Japanese markets. Statewide herring harvests have
40 averaged approximately 45,000 mt in recent years, with a value of approximately \$30 million. In
41 addition, commercial fisheries for herring eggs on kelp harvest about 400 mt of product annually
42 with a value of approximately \$3 million.
43

44 At present, the state fishery is located in the following areas: Prince William Sound, Cook Inlet,
45 Kodiak, Alaska Peninsula, Bristol Bay, Kuskokwim, Norton Sound, Southeast, and Port
46 Clarence. Fisheries in the Southeast and Port Clarence regions are not likely to affect the
47 western population of Steller sea lions and are not considered further. Approximately 25 distinct
48 fisheries for Pacific herring occur in these regions. Harvest methods are by gillnet, purse seine,

1 and handpicking of roe from kelp. Herring are primarily caught for their roe during the sac roe
2 harvest in the spring. On occasion the entire allowable harvest has been taken in less than one
3 hour, although most sac roe fisheries occur during a series of short openings of a few hours each,
4 spanning approximately one week. Fishing is not allowed between these short openings to allow
5 processors time to process the catch, and for managers to locate additional herring of marketable
6 quality.

7
8 Spawn-on-kelp fisheries harvest intertidal and subtidal macroalgae containing freshly deposited
9 herring eggs. Both of these fisheries produce products for consumption primarily in Japanese
10 domestic markets. Smaller amounts of herring are harvested from late July through February in
11 herring food/bait fisheries. Most of the herring harvested in these fisheries are used for bait in
12 hook-and-line and pot fisheries for groundfish and shellfish. Smaller amounts are used for bait in
13 salmon troll fisheries. When herring harvested during spring sac roe fisheries produce low
14 quality roe, they are then sold as food/bait herring, although for regulatory purposes the catch is
15 included as part of the sac roe quota. Herring spawn timing is temperature dependent, so that
16 herring spawning and roe harvest timing occurs progressively later from southeast Alaska, where
17 spawning begins in March, through the northern Bering Sea, where spawning ends in June.

18
19 GOA herring have some genetic distinction from Bering Sea herring and are smaller and non-
20 migratory, generally moving less than 100 miles among spawning, feeding, and wintering
21 grounds. Bering Sea herring are much larger and longer lived. Most travel to offshore central
22 Bering Sea wintering grounds, with some herring migrating over 1,000 miles annually. Herring
23 are planktivores and provide a key link in pelagic and nearshore food chains between primary
24 production and upper-level piscivores.

25
26 Harvest policies used for herring in Alaska set the maximum exploitation rate at 20% of the
27 exploitable or mature biomass. The 20% exploitation rate is considered to be lower than
28 commonly used biological reference points for species with similar life history characteristics. In
29 some areas, such as Southeast Alaska, a formal policy exists for reducing the exploitation rate as
30 the biomass drops to low levels. In other areas, the exploitation rate is similarly reduced, without
31 a formal policy. In addition to exploitation rate constraints, minimum threshold biomass levels
32 are set for most Alaskan herring fisheries. If the spawning biomass is estimated to be below the
33 threshold level, no commercial fishing is allowed. Threshold levels are generally set at 25% of
34 the long-term average of unfished biomass (Funk and Rowell 1995).

35
36 Most herring fisheries in Alaska are regulated by management units or regulatory stocks (i.e.,
37 geographically distinct spawning aggregations defined by regulation). Those aggregations may
38 occupy areas as small as several miles of beach or as large as all of Prince William Sound.
39 Herring sac roe and spawn-on-kelp fisheries are always prosecuted on individual regulatory
40 stocks. Management of food and bait herring fisheries can be more complicated because they are
41 conducted in the late summer, fall, and winter when herring from several regulatory stocks may
42 be mixed together on feeding grounds distant from the spawning areas. Where possible, the BOF
43 avoids establishing bait fisheries that harvest herring from more than one spawning population.

44
45 The 1999 harvest of herring for sac roe of approximately 38,000 tons is less than the recent
46 average harvest of approximately 48,000 tons, because of lower abundance in some areas.
47 Allowable harvest quotas in some areas were not entirely taken in 1999 because of marketing and
48 processing considerations. The major populations of herring in Alaska are at moderate levels and
49 in relatively stable condition, with the exception of Prince William Sound and Cook Inlet.

1 **5.5.4.3 State salmon fisheries**
2

3 Commercial salmon fishing in Alaska began in the 1880s (Fig 5.7). Initial commercial harvests
4 were primarily salted, and canning became predominant at the turn of the century. After the
5 United States purchased Alaska in 1867, the U.S. Federal government had jurisdiction over these
6 fisheries until statehood. The White Act, passed in 1924, required a closure of the fishery after
7 the halfway point of the runs. At that time, much of the catch was taken in large fish traps.
8 Federal management was weak, poorly funded, and ineffectively enforced.
9

10 After World War II, W. F. Thompson of the University of Washington began investigations of
11 salmon and their management in Alaska. After statehood in 1959, the state of Alaska took over
12 salmon management. Fish traps were banned. Based on the work of W. F. Thompson and his
13 students, ADFG implemented a management system based on maintaining a constant stock size,
14 and a program to find stock sizes that maximize the yield. A network of regional and area offices
15 was created to closely monitor local salmon runs and to open and close fisheries to meet
16 conservation mandates. A state fish and wildlife enforcement program was instituted to assure
17 compliance. Largely as a result of this management system, adequate enforcement, and
18 commitment to salmon resource conservation, the fishing industry in Alaska has enjoyed the full
19 benefit of the salmon resource when the environment has been favorable for large fish runs. The
20 industry has accepted and encouraged restrictions during years of low runs. In general these
21 salmon runs are considered rebuilt, and are at or near record abundances (Fig 5.7).
22

23 The state salmon fishery includes five species: chinook, sockeye, coho, pink, and chum. These
24 fisheries are divided into southeast, Prince William Sound, Cook Inlet, Bristol Bay, Kodiak,
25 Chignik, Alaska Peninsula, Kuskokwim, Yukon, Norton Sound, and Kotzebue management
26 areas. Salmon are taken by purse seines, gill nets, trolling, and beach seining via an extensive
27 small boat fleet. The catch in 2000 was about 135 million fish. Economically, the salmon
28 fishery is worth more than all other state fisheries combined. The fisheries are managed for
29 minimum escapement goals, where regional ADFG biologists have determined what level of
30 escapement seems to produce the maximum yield per year. These methods have not been
31 standardized, and range from aerial flights to determine if the streams are “full” to fish weirs and
32 remote sonar counters. The timing of the fisheries correspond with the various spawning time
33 for each run, which is highly variable and which is managed on a stream by stream basis.
34

35 **5.5.4.4 State managed crab fisheries**
36

37 The state manages all crab fisheries in the BSAI and GOA, although State management in the
38 BSAI is subject to a federal FMP for the crab fishery. King (brown, red, blue), Dungeness, and
39 Tanner crabs are taken by hand-picking, shovel, trawl, pot, and dredge gear. Crab fisheries
40 began in the early 1960s when the stocks were abundant, then declined in the mid-1980s into the
41 1990s (Fig. 5.8). State crab fisheries occur in Bristol Bay, Dutch Harbor, Alaska Peninsula,
42 Kodiak, Cook Inlet, Adak and W. Aleutian Islands, and Prince William Sound. Crab fisheries
43 primarily occur during the winter season. Over the past ten years, the industry has focused on
44 Alaska snow crab (*C. opilio*), and the catch has exceeded historical levels of king crab harvests
45 from the late 1970s.
46

47 Most westward crab stocks were not healthy in 1999. All major red king crab stocks, except
48 those in Norton Sound, BB, and the Pribilof Islands, were very low in abundance and continue to
49 decline. Consequently, these fisheries have been closed for sometime. Bering Sea Tanner crab

1 has been declared overfished and closed since 1997. St. Matthew and Pribilof Islands blue king
2 crab fisheries have been closed since 1999 due to low stock abundance. The Bering Sea snow
3 crab GHL was drastically reduced in 1999 because of stock decline.
4

5 Crab species harvested in 1999 included red king, blue king, golden king, scarlet king, snow,
6 Dungeness, and Korean hair crab. Approximately 96,302 t of crab was landed with BS snow crab
7 dominating the total harvest. The 1999 harvest consisted of snow crab 91.5%, red king crab
8 5.6%, golden king crab 2.5%, Dungeness crab 0.3%, Korean hair crab 0.1%, and scarlet king
9 crab <0.0001%. Exvessel prices were high for Bristol Bay and AI king crabs due to stable Asian
10 economies, increased domestic demand for crab, decreased Russian production, and closures of
11 Pribilof Islands and St. Matthew Island king crab fisheries.
12

13 **5.5.4.5 State shrimp fisheries**

14
15 Five species are targeted in Alaska shrimp fisheries: northern (formerly, pink) shrimp, *Pandalus*
16 *borealis*; sidestriped shrimp, *Pandalopsis dispar*; coonstriped shrimp, *Pandalus hypsinotus*; spot
17 shrimp, *Pandalus platyceros*; and humpy shrimp, *Pandalus goniurus*. In 1999, northern and
18 sidestriped shrimp contributed to almost all the landings from the areas west of 144° W long.
19 (PWS, Cook Inlet, Kodiak, AI coasts, and BS [Pribilof Islands and St. Matthew Island]). Shrimp
20 resources in Alaskan waters have been exploited since 1915, but catch records are only available
21 since the mid-1960s. Effort was highest during the late 1970s and 1980s, but has undergone
22 severe declines in most areas (Fig 5.8). Currently, the shrimp fishery occurs in the southeast and
23 Yakutat areas, and to a lesser extent in Prince William Sound, Kodiak, Dutch Harbor, Cook Inlet,
24 and the Alaska Peninsula. Shrimp are harvested by pot gear and often sold to floating
25 processors. In 1995, over 45,000 mt of shrimp were harvested by 351 vessels. In the last ten
26 years, effort has increased in the southeast due, in part, to the availability of floating processors,
27 which allow fishing vessels to devote more of their time to fishing. Harvest strategy for shrimp
28 is based on a minimum biomass estimate by region, the plan is to maintain the biomass above
29 that level, where a fishery could occur at a harvest rate up to 20%. However, biomass estimates
30 and recruitment are largely unknown for shrimp.
31

32 **5.5.4.6 State shellfish (invertebrate) fisheries**

33
34 Clam, abalone, octopus, squid, snail, scallop, geoduck clams, sea urchins, and sea cucumbers
35 have been harvested throughout the state. Most of the catch of shellfish is taken from April to
36 September, and they are taken by hand-picking, shovel, trawl, pot, and dredge gear. Harvest
37 levels were relatively consistent through the 1980s, but have increased dramatically in amount
38 and annual variation in the 1990s. The variability has been due, in large part, to recent but
39 sporadic catches in Bristol Bay and the Bering Sea, areas not usually fished for shellfish. With
40 the exception of the recent large catches in these areas, most of the shellfish fisheries have
41 traditionally taken place in the Kodiak and Cook Inlet areas. Limited stock assessment surveys
42 are available for these species, and almost all of the above invertebrates are managed with GHLs
43 based on past fishery performance data.
44

45 Of all the above invertebrates, the giant Pacific octopus (*Octopus dofleini*) and squid
46 (*Berryteuthis magister*) are the most likely prey of sea lions. Octopus, is harvested in all Alaskan
47 waters primarily as bycatch in groundfish pot (mostly Pacific cod), trawl, and hook-and-line
48 fisheries. Squid is also taken as bycatch in shrimp and groundfish trawl fisheries.
49

5.5.4.7 Interactions between State fisheries and listed species

Direct interactions between the fisheries and listed species would include direct take (mortality), disturbance (e.g., disturbance of a sea lion haulout), vessel noise, entanglement in nets, and among others, preclusion from foraging areas due to active fishing vessels. NMFS has already issued a comprehensive biological opinion for the southeast Alaska salmon troll fishery (NMFS 1999) that evaluates the fishery's impacts on listed salmon.

Direct take of listed species (cetaceans, Steller sea lions, and leatherback sea turtles) are expected to be very low relative to other mortality. Accurate estimates of take in the state fishery are not available due to lack of observer coverage. Estimates in the Federal fishery place the annual mortality at around 30 Steller sea lions. In the 1970s, the crab fleet purportedly killed sea lions for bait; however, the numbers killed are not known.

Perhaps the most important interaction between state fisheries and listed species arises from the intense pattern of localized removals of spawners. Although the patterns are generally similar from one fishery to the next, the sheer number of distinct fisheries make it difficult to describe them individually. Likewise, each fishery is distinctly different in either the number of boats, gear used, time of year, length of season, and fish species. Therefore, a few examples are presented to demonstrate some of the competitive interactions which may occur.

Direct interactions between Steller sea lions and herring fisheries could occur if vessel activity interferes with sea lions foraging in the area, or if mortality results from fishery-sea lion interactions. Steller sea lions are attracted to areas where herring spawn; they are likely feeding on the dense aggregations of herring present during the short spawning period. Because herring spawn timing is somewhat variable, fishery managers have learned to depend on the presence of Steller sea lions to determine when herring spawning is imminent. Managers generally begin flying aerial surveys over potential herring spawning grounds well in advance of the expected spawning event. For several weeks prior to spawning, herring are usually present adjacent to the spawning grounds, but they occur in depths too deep to be detected from aircraft. However, the presence of Steller sea lions and cetaceans on the spawning grounds alerts the fishery manager to the presence of herring and impending spawning. Fishery managers usually note the presence of Steller sea lions in their field notebooks, occasionally recording actual counts.

Several days before spawning, herring move into shallower water and become directly detectable by aerial surveyors. About this time the fishing fleet begins arriving in the general area where the fishery will take place. Several hours before the opening, the fishing fleet moves into position, directed to the herring schools by spotter aircraft. Fishery openings, particularly purse seine openings, can be very short, on the order of 30 minutes, with a number of openings over a few days or a week. Steller sea lions have been observed in the middle of these fishing areas. There is not sufficient information to know whether these animals are there because they are not being disturbed and have no fear of the fishing vessels, or if they are the brave few venturing out into the disturbed area. Additionally, there is no way of knowing how many animals were excluded that were not observed foraging in the spawning area. Steller sea lions are observed leaving the grounds within a few days after the herring have spawned. Fishery biologists make note of their departure, as spawn deposition SCUBA biomass survey assessments do not begin, for safety reasons, until the sea lions leave the area.

One example of a herring spawning event where Steller sea lion counts were quantified during

1 aerial surveys is shown in Figure 5.9. There was no fishery at Hobart Bay in the spring of 2000
2 because the quota had been taken in the earlier food/bait herring fishery. However, if a fishery
3 had occurred, managers would typically have allowed 6-12 hours of gillnet fishing about April
4 29. Steller sea lions were already in the area at the time of the first ADF&G aerial survey on
5 April 19, diving on the deeply submerged herring schools, as were a number of humpback
6 whales. Following the spawning event, large numbers of birds appeared on the beaches to feed
7 on the herring eggs, noted in numbers of 11,000 to 20,000. Approximately 150 Steller sea lions
8 were counted in the area. Similar descriptions of humpback whale and Steller sea lion presence
9 on herring spawning grounds are available in field notes from other herring fishing areas.

10
11 Steller sea lions and humpback whales are seen foraging extensively on herring schools, ADFG
12 uses that behavior to signal the fishery, then the fishery moves in and eliminates entire schools of
13 herring at peak condition. The entire fishery may last only about a week or two, but given the
14 short spawning period when these stocks are concentrated and are easy prey for fisherman,
15 marine mammals, and seabirds, that time may be essential to the survival of animals such as
16 Steller sea lions. They may depend on these short intervals of high prey availability to get them
17 through other bottle neck periods of low prey availability. However, in many instances they are
18 instead faced with dozens of boats removing whole schools of prey. Some animals may be able
19 to adapt, by learning to forage among the fishing boats, but others may choose to avoid the area.
20 These are the animals that we do not see and have no reliable way to estimate. For animals that
21 remain, we have no way to gauge their foraging success among the fishing vessels, nor do we
22 have a way to gauge the impact on the animals that were excluded.

23
24 Additional interactions may occur in the salmon fisheries. Many of these fisheries take place at
25 stream or river outlets where salmon congregate before heading up to spawn. Vessels converge
26 on these areas and fish in tight groups, setting driftnets or purse seines. Again, sea lions may be
27 excluded from this rich foraging area by direct vessel and fishing gear interactions.

28 29 **5.5.5 Direct effects of commercial fisheries on listed species**

30 31 **5.5.5.1 Direct effects on Steller sea lions**

32
33 Commercial fisheries can directly affect Steller sea lions in the BSAI, and GOA by capturing ,
34 injuring, or killing them in fishing gear or in collisions with fishing vessels, and if fishermen kill
35 them intentionally. Observations of Steller sea lions entangled in marine debris have been made
36 throughout the GOA and in southeast Alaska (Calkins 1985), typically incidental to other sea
37 lion studies. Two categories of debris, closed plastic packing bands and net material, accounted
38 for the majority of entanglements. Loughlin *et al.* (1986) surveyed numerous rookeries and
39 haulout sites to evaluate the nature and magnitude of entanglement in debris on Steller sea lions
40 in the Aleutian Islands. Of 30,117 animals counted (15,957 adults; 14,160 pups) only 11 adults
41 showed evidence of entanglement with debris, specifically, net or twine, not packing bands or
42 other materials. Entanglement rates of pups and juveniles appear to be even lower than those
43 observed for adults (Loughlin *et al.* 1986). It is possible that pups were too young during the
44 survey to have encountered debris in the water or that pups and juveniles were unable to swim to
45 shore once entangled and died at sea. Trites and Larkin (1992) assumed that mortalities from
46 entanglement in marine debris were not a major factor in the observed declines of Steller sea
47 lions and estimated that perhaps fewer than 100 animals are killed each year.

48
49 Steller sea lions have been caught incidental to foreign, commercial trawl fisheries in the BSAI

1 and GOA since those fisheries developed in the 1950s (Loughlin and Nelson 1986, Perez and
2 Loughlin 1991). Alverson (1992) suggested that from 1960 to 1990, over 50,000 sea lions were
3 incidentally taken in these fisheries, or almost 40% of his estimated total mortality due to various
4 fishery and subsistence activities. Perez and Loughlin (1991) reviewed fisheries and observer
5 data and reported that from 1973 to 1988, sea lions comprised 87% (over 3000) of the marine
6 mammal incidental take reported by observers. They extrapolated the take rate to unobserved
7 fishing activities and suggested that the incidental take during 1978 to 1988 was over 6,500
8 animals. Using the average observed incidental rates during 1973 to 1977, they also estimated
9 that an additional 14,830 animals were incidentally taken in the trawl fisheries in Alaska during
10 1966 to 1977. Finally, they concluded that incidental take was a contributing cause of the
11 population decline of Steller sea lions in Alaska, accounting for a decline of 16% in the BSAI
12 and 6% in the GOA. However, because the actual decline has exceeded 80% since 1960, sea
13 lions deaths incidental to fishing operations do not appear to be the principal factor in their
14 decline.

15
16 More recent estimates suggests that the number of sea lions killed incidental to commercial
17 fisheries in the action area has declined substantially from historic levels. The average number of
18 Steller sea lions that were estimated to have been killed each year incidental to BSAI and GOA
19 groundfish trawl and longline fisheries for 1990 to 1996 was 11 animals and the estimate from
20 the Prince William Sound salmon drift gillnet fishery was 15 animals; resulting in a total
21 estimated mean mortality rate in observed fisheries of 26 sea lions per year from the endangered
22 western stock (Hill and DeMaster 1998). Another 30 Steller sea lions were believed to be killed
23 each year in interactions with state fisheries, although these estimates are not reliable. Hill and
24 DeMaster (1998) estimated that 10 Steller sea lions from the eastern population were taken by
25 fisheries in southeast Alaska.

26
27 Satellite tracking studies suggest that Steller sea lions rarely go beyond the U.S. EEZ into
28 international waters. Given that the high-seas gillnet fisheries have ended and other net fisheries
29 in international waters are minimal, the probability that significant numbers of Steller sea lions
30 are taken incidentally in commercial fisheries in international waters may be low. NMFS has
31 concluded that the number of Steller sea lions taken incidental to commercial fisheries in
32 international waters is too small to have measurable effects on the population dynamics of Steller
33 sea lions (Hill and DeMaster 1998).

34 35 **Intentional take of Steller sea lions**

36
37 Historically, Steller sea lions and other pinnipeds were seen as nuisances or competitors
38 by the fishing industry and fishery management agencies. Steller sea lions damaged
39 fishing gear, damaged fishermen's catch, and were believed to compete for fish
40 (Mathisen *et al.* 1962). As a result, the Federal and state government sanctioned efforts
41 to reduce the size of the sea lion population through bounty programs, controlled hunts,
42 and indiscriminate shooting. As noted previously, Steller sea lions were also killed for
43 bait in crab fisheries managed by the State of Alaska.

44
45 The total number of sea lions killed between 1900 and 2000 is unknown. Alverson
46 (1992) suggested that intentional take may have reached or exceeded 34,000 animals
47 from 1960 to 1990. Fishermen were seen killing adult animals at rookeries, haulout
48 sites, and in the water near boats. The loss of that many animals would have an
49 appreciable effect on the population dynamics of sea lions, but the effect would not

1 account for the total decline of the western population. The effect was likely
2 concentrated in areas closer to fishing communities and less important in more isolated
3 areas (e.g., central and western Aleutian Islands).
4

5 Government-sanctioned efforts to control the population of Steller sea lions stopped in
6 1972 with the passage of the MMPA. Sea lion populations appear to be growing slowly
7 in southeast Alaska, where considerable commercial fishing occurs. Expanded observer
8 coverage in the domestic groundfish fishery after 1989 and increased public awareness
9 of the potential economic and conservation impacts of continued sea lion declines have
10 probably reduced the amount of shooting. Nevertheless, anecdotal reports of shootings
11 continue and a small number of prosecutions still occur. The full extent of incidental
12 killing is undetermined and therefore should be considered a potential factor in the
13 decline of sea lions at some locations.
14

15 16 **5.5.5.2 Direct effects on critical habitat for Steller sea lions**

17
18 Commercial fisheries in the action area would have affected critical habitat that has been
19 designated for Steller sea lions primarily through the effects on the value of critical habitat to
20 Steller sea lions (discussed under indirect effects below). Critical habitat has not been designated
21 for any other listed species covered by this biological opinion.
22

23 **5.5.5.3 Direct effects on cetaceans**

24
25 Commercial fisheries can directly affect endangered cetaceans in the BSAI, and GOA by
26 capturing , injuring, or killing them in fishing gear or in collisions with fishing vessels, and if
27 fishermen kill them intentionally. In the biological opinions NMFS has prepared on commercial
28 fisheries in the action area over the past 20 years, NMFS has identified very few direct effects on
29 endangered cetaceans. However, information on the direct effects of commercial fisheries on
30 whales in the action area has been limited until recently. In 1997, for example, a humpback
31 whale was entangled in longline gear (pots for brown king crab). This whale was freed when the
32 line was cut, but reports on the incident are unclear about whether the whale was injured during
33 the incident. NMFS has generally considered commercial fisheries in the action area to have
34 negligible effects on endangered cetaceans (Hill and DeMaster 1999).
35

36 **5.5.5.4 Direct effects on salmon**

37
38 The available information does not allow us to characterize the stock composition of the chinook
39 bycatch in the groundfish fisheries. Consequently, we cannot estimate how the various fisheries
40 in the action area have affected mortality rates of threatened and endangered salmonids over
41 time. However, at least small numbers of some listed salmonids have been caught as bycatch in
42 Alaska groundfish fisheries.
43

44 Chinook salmon rear in freshwater followed by 2-4 years of ocean feeding before they begin
45 their spawning migration. Chinook from individual brood years can return over a 2-6 year period,
46 although most adult chinook return to spawn as 4 and 5 year old fish. Chinook salmon migrate
47 and feed over great distances during their marine life stage; some stocks range from the
48 Columbia River and coastal Oregon rivers to as far north as the ocean waters off British
49 Columbia and Alaska. As a result, cohorts of chinook salmon can be vulnerable to fisheries for

1 several years. Most chinook stocks are vulnerable to harvest by numerous commercial troll, sport
2 and commercial net fisheries in marine areas. Many are also taken in rivers and streams during
3 their spawning migration by sport, commercial net and subsistence fishermen.
4

5 Their extended migrations and the extreme mixed stock nature of most chinook fisheries greatly
6 complicates the management of chinook salmon. Prior to the mid-1970s, the extent of chinook
7 migration and the impacts of ocean fisheries on particular chinook stocks was poorly understood.
8 This changed with the advent of the Coded-wire tags and extensive tagging programs; large scale
9 tagging of chinook made it possible for fishery managers to determine chinook migration routes,
10 the timing of their migrations, and stock-specific impacts in distant fisheries. This kind of
11 information, though sparse by today's standards, was used to establish the original harvest
12 ceilings for ocean fisheries.
13

14 **Snake River fall chinook**

15
16 There is little direct information regarding the impact of NPFMC groundfish fisheries on
17 Snake River fall chinook. There have been no recoveries of tagged fall chinook from the
18 Snake River in either the BSAI or GOA groundfish fisheries. Coded-wire tags
19 recoveries of the Snake River hatchery indicator stock in the ocean salmon fisheries
20 indicate that the greatest concentration of recoveries occurs off the southern British
21 Columbia and Washington coasts. Tags have been recovered from southern California to
22 southeast Alaska, but the concentration of Snake River fall chinook expressed in terms of
23 listed fish caught per thousand chinook is much lower in these more distant areas
24 suggesting that they are being sampled from the margins of their distribution.
25

26 Although no Snake River fall chinook have been recovered in the NPFMC groundfish
27 fisheries, there have been several observed recoveries of upper Columbia River fall
28 chinook (known as upriver brights) in the GOA groundfish fisheries. Upriver Brights are
29 known to have a more northerly distribution than Snake River fall chinook based on a
30 longer and much more extensive tagging history. The presence of Upriver Brights in the
31 GOA fishery suggests that the occasional occurrence of Snake River fall chinook in
32 NPFMC groundfish fisheries is at least plausible.
33

34 As discussed in the *Status of the Species* section of this opinion, virtually all chinook
35 caught in the Bering Sea are considered stream-type fish. Myers et al. (1996) used scale
36 samples to determine general life history characteristics and major region of origin for
37 chinook taken as bycatch in the eastern Bering Sea. They estimated that only about four
38 percent of the bycatch were ocean-type fish comparable to Snake River fall chinook or
39 other fall chinook stocks. If one assumes an annual chinook bycatch in the BSAI of
40 55,000 (from the most recent biological opinion, NMFS 1995b), then only a small
41 portion, about 2,200, ($55,000 * 0.04$) are ocean-type fish that could be Snake River fall
42 chinook. However, existing information continues to suggest that it is unlikely that
43 Snake River fall chinook will be caught in the BSAI fisheries.
44

45 The southeast Alaska salmon fisheries represent the closest geographic region where
46 estimates of the relative abundance of Snake River fall chinook are available. The
47 concentration of Snake River fall chinook in the fishery has been estimated at about 0.3
48 per thousand for the 1987 - 1991 time period. A similar analysis for the 1985 - 1991
49 time period resulted in an estimate of 0.2 per thousand (PSC 1992). (These estimates

1 were derived using the PSC chinook model.) Other estimates developed using the PFMC
2 chinook model have ranged from 0.5 to 1.1 Snake River fall chinook per thousand
3 depending on the time period and assumptions used in the analysis (NMFS 1993).
4 Higher concentrations were generally observed when analyzing 1993 than when
5 averaging estimated concentrations over a longer time period.
6

7 Snake River fall chinook are observed in the southeast Alaska fisheries, but in
8 concentrations that are substantially lower than in southern fisheries. It is reasonable to
9 assume that the concentration of listed fish will continue to decrease to the north. Given
10 the great additional distance to the BSAI area, the low abundance of ocean-type fish in
11 the BSAI area, and the relatively few Snake River fall chinook compared to the more
12 populous ocean-type stocks from the British Columbia and Washington and Oregon
13 production areas, NMFS concludes that it is highly unlikely that any Snake River fall
14 chinook are taken in BSAI groundfish fisheries.
15

16 It is more difficult to assess the potential impacts of the GOA groundfish fisheries on
17 Snake River fall chinook because there is no information on the origin of chinook taken
18 in the groundfish fisheries. It is reasonable to assume that the Snake River fall chinook in
19 the GOA groundfish fisheries will be lower than that observed in the southeast Alaska
20 salmon fisheries because of the greater distance from the apparent center of their
21 distribution. Similarly, it is reasonable to assume that there will be more stream-type
22 fish in the GOA groundfish fishing areas than in the southeast Alaska fishery based on
23 their observed dominance in the BSAI area. In 1999, NMFS produced a very
24 conservative estimates of the possible occurrence of chinook salmon in GOA groundfish
25 fisheries by multiplying concentration factors for the southeast Alaska salmon fishery by
26 the assumed maximum chinook bycatch of 40,000 (NMFS 1999a). This analysis suggests
27 that the catch of Snake River fall chinook could be as high as 8 to 44 fish per year (i.e.,
28 $40,000 * 1.1$ Snake River fall chinook per thousand (from previous discussion) = 44).
29 However, this analysis does not account for expected decreases in the concentration of
30 listed fish in the more northerly GOA groundfish fisheries. Based on that analysis,
31 NMFS concluded that the catch of Snake River fall chinook in the GOA groundfish
32 fishery is unlikely to average not more than five per year.
33

34 **Upper Willamette River chinook**

35
36 About 33 chinook salmon coded-wire tags from the upper Willamette River have been
37 recovered from GOA groundfish fisheries and one in BSAI groundfish fisheries since
38 1986. However, the number of upper Willamette River chinook salmon that were
39 intercepted in relation to the amount caught in directed salmon fisheries in southeast
40 Alaska and British Columbia is very low. Although it is impossible to extrapolate these
41 observed recoveries into exploitation rates, NMFS believes that the take of these chinook
42 is a relatively rare event. Two to three of these coded-wire tags have been recovered per
43 year, with none recorded in the last 3 years. In 1993, 11 upper Willamette River chinook
44 salmon were recovered in GOA fisheries, which is the highest number of any year since
45 1986.
46

47 **Lower Columbia River chinook**

48
49 These spring stocks have a wider ocean distribution than most stocks originating in the

1 lower Columbia River, and are impacted by ocean fisheries off Alaska, Canada, and the
2 southern U.S. They were also subject, in past years, to significant sport and commercial
3 fisheries inside the Columbia. Since 1984, there have only been 9 LCR Coded-wire tags
4 recoveries in GOA groundfish fisheries, indicating that it is a relatively rare event.
5

6 The three tule stocks in the ESU include those on the Coweeman, East Fork Lewis, and
7 Clackamas rivers. These are apparently self-sustaining natural populations without
8 substantial influence from hatchery-origin fish. These stocks are all relatively small.
9 Since 1984, there have no reported Coded-wire tags recoveries in BSAI or GOA
10 groundfish fisheries for this ESU component. The interim escapement goals on the
11 Coweeman and East Fork Lewis are 1,000 and 300, respectively. Escapements have been
12 below these goals 8 of the past 10 years for the Coweeman, and 5 of the past 10 years for
13 the East Fork Lewis. The 10 year average escapement for the Coweeman is 700 ,
14 compared to a recent 5 year average of 995 (range 146-2,100). In the East Fork Lewis,
15 the 10 year average escapement is 300, compared to a recent 5 year average of 279.
16 There is currently no escapement goal for the Clackamas where escapements have
17 averaged about 350 per year.
18

19 Three natural-origin bright stocks have also been identified. There is a relatively large
20 and healthy stock on the North Fork Lewis River. Since 1984, there have no reported
21 Coded-wire tags recoveries in BSAI or GOA groundfish fisheries for this ESU
22 component. The escapement goal for this system is 5,700. That goal has been met, and
23 often exceeded by a substantial margin every year since 1980 with the exception of 1999.
24 This year the return is expected to be substantially below goal because of severe flooding
25 during the 1995 and 1996 brood years. Nonetheless, the stock is considered healthy. The
26 Sandy and East Fork Lewis stocks are smaller. Escapements to the Sandy have been
27 stable and on the order of 1,000 fish per year for the last 10-12 years. Less is known
28 about the East Fork stock, but it too appears to be stable in abundance.
29

30 **Puget Sound Chinook salmon**

31
32 There have been no reported Coded-wire tags recoveries from the PS ESU in BSAI or
33 GOA groundfish fisheries.
34

35 **Snake River Spring/Summer and Upper Columbia River spring chinook**

36
37 The available information suggests that UCRS chinook are rarely caught in the proposed
38 BSAI and GOA groundfish fisheries. The PFMC Salmon Technical Team previously
39 reviewed the record of coded-wire tag recoveries of spring and summer chinook from the
40 Snake River and other relevant information regarding distribution and harvest related
41 mortality. There were no Coded-wire tags recoveries or other information to suggest that
42 Snake River spring/summer chinook are caught in Alaskan fisheries (PFMC 1992, Clark
43 et. al. 1995). There were also no recoveries from summer chinook releases were reported
44 from Alaskan fisheries.
45

46 **Sockeye salmon**

47
48 Although the ocean distribution and migration patterns of Snake River sockeye and
49 Ozette Lake sockeye are not well understood, catch information suggest that they are

1 unlikely to be caught in proposed groundfish fisheries of the BSAI and GOA. NMFS
2 found no information to suggest that there is any significant harvest of Snake River
3 sockeye salmon in ocean fisheries (November 20, 1991, 56 FR 58619). NMFS
4 previously concluded that Snake River sockeye are not likely to be caught in BSAI and
5 GOA groundfish fisheries because few sockeye salmon are caught in trawl or hook-and-
6 line fisheries that rarely intercept sockeye salmon. Given the low total abundance of
7 Snake River and Ozette Lake sockeye salmon, they are not likely to be taken in BSAI or
8 GOA groundfish fisheries.
9

10 **Columbia River steelhead**

11
12 Lower Columbia River and Upper Willamette River steelhead ESUs are coastal
13 steelhead stocks. The Upper Willamette River stocks are winter run stocks; the Lower
14 Columbia River steelhead stocks are primarily winter run although there are a few
15 summer run stocks in the upriver portion of the ESU. Upper Columbia River, Snake
16 River, and Middle Columbia River steelhead ESUs include inland stocks generally
17 comprised of summer-run fish (Busby et al 1996).
18

19 The summer-run steelhead generally enter freshwater from May through October (Busby
20 et al 1996) with peak entry occurring in July based on timing at Bonneville dam. Mark
21 recoveries indicate that immature Columbia River steelhead are out in the mid North
22 Pacific Ocean at this time. Data from high seas tagging studies found maturing summer-
23 run Columbia River steelhead distributed off the coast of Northern British Columbia and
24 west into the North Pacific Ocean (Myers et al 1996). Coded-wire tag data indicates
25 summer-run steelhead are also present off the West Coast of Vancouver Island, with
26 occasional recoveries in near shore Canadian fisheries.
27

28 The Lower Columbia River and Upper Willamette steelhead winter-run stocks enter
29 freshwater from November through April (Busby et al. 1996). As mentioned above, the
30 ocean distribution of winter-run steelhead is far offshore as compared with their summer
31 counterparts, although coded-wire tag data indicates they are found as far east as the
32 west coast of Vancouver Island. Adults move rapidly back to the Columbia River once
33 the migration begins, averaging 50 km/day mean straight-line-distance (range = 15-85
34 km/day).
35

36 The ocean distributions for listed steelhead are not known in detail, but steelhead are
37 caught only rarely in ocean salmon fisheries and are, therefore, not likely to be caught in
38 BSAI and GOA groundfish fisheries (ODFW/WDFW 1998). For the salmon fishery in
39 Alaska, during 1982-1993, when the southeast Alaska seine landings were sampled for
40 tagged steelhead, only one tag was recovered, although tag releases of southern U.S.
41 steelhead were quite high. Since then, only one other steelhead coded-wire tags has been
42 recovered while sampling for other species. From 1995 through 1999, no steelhead were
43 reported as bycatch in the "other" salmon bycatch category in the BSAI or GOA.
44

45 **5.5.5.5 Direct effects on leatherback turtles**

46
47 NMFS has no evidence that there are any direct effects of commercial fisheries in the BSAI, and
48 GOA on the continued existence of leatherback turtles.
49

1 **5.5.6 Indirect effects of commercial fisheries on listed species**
2

3 Commercial fisheries have numerous indirect effects the include social effects, economic effects,
4 physical effects, chemical effects, and biotic effects. Other indirect effects of commercial fisheries
5 include the industrial infrastructure to process the catch and deliver the catch to markets. Fisheries can
6 also have indirect biological effects that occur when fisheries remove large numbers of target species and
7 non-target species (bycatch) from a marine ecosystem. These removals can change the composition of the
8 fish community with associated effects on the distribution and abundance of prey organisms. Fishery
9 removals of biomass can also compete with other consumers that depend on target organisms for food.
10 These biological effects are generally termed cascade effects and competition.
11

12
13 **5.5.6.1 Indirect effects on water quality**
14

15 After fish are harvested in the ocean, they are usually processed before they are delivered to
16 markets. Seafood processing covers a range of activities that can be as simple as removing
17 viscera and storing whole fish on ice, it can require cutting fish into fillets or steaks, or it can
18 involve more processing to form products like surimi or fish meal. Seafood processing generates
19 waste that consist of highly biodegradable constituents such as tissue solids, oil and grease, along
20 with fluids from viscera, heads, bones, and other discarded materials. The major constituents that
21 are not highly degradable are crab and shrimp shells. These materials are usually ground up
22 before being discharged from seafood processing facilities.
23

24 The adverse effects of discarding this material tend to be highly local and usually depend on
25 flushing rates and dispersal regimes of the receiving waters. When discharges exceed the
26 dispersion and biodegradation rates of the receiving waters, they can build up, increase the
27 biological oxygen demand of the receiving waters, and can produce noxious smells. Waste
28 generated by seafood processing can cause receiving waters to become anoxic, can elevate
29 ammonia levels, can smother benthic organisms, and attract scavengers such as gulls or rodents,
30 which may cause public health problems (Patten and Patten 1979).
31

32 In the 1970s, fish and shellfish waste discharged from mobile and shore-based processors at
33 Kodiak, Dutch Harbor, and Akutan polluted coastal waters around those communities. In 1971,
34 about 3.3×10^4 mt of waste was discharged at Kodiak (Jarvela 1986). In 1976, about 2.1×10^4 mt
35 of waste was discharged at Dutch Harbor. In 1983, the shore-based Trident Seafoods plant at
36 Akutan released between 9 and 11×10^4 mt of codfish and crab wastes into Akutan Harbor
37 before the plant was destroyed by fire. Sonar surveys of Akutan Harbor identified a waste pile
38 that was about 7 m thick and 200 m in diameter.
39

40 Section 303(d)(1)(C) of the Clean Water Act and the EPA's implementing regulations (40 CFR
41 130) require the establishment of a Total Maximum Daily Load (TMDL) to achieve state water
42 quality standards when a body is limited by water quality. A TMDL identifies the degree of
43 pollution control needed to maintain compliance with standards using an appropriate margin of
44 safety. The focus of the TMDL is reduction of pollutant inputs to a level (or load) that fully
45 supports the designated uses of a given waterbody. In 1997, the Alaska Department of
46 Environmental Conservation (AKDEC) identified Udagak Bay (Beaver Inlet on Unalaska Island
47 in the Aleutian Islands) and King Cove lagoon in King Cove (on the Alaska Peninsula in the
48 Aleutians East Borough) as being water quality-limited for seafood wastes. TMDLs were
49 established for both facilities in 1998.

1 For Udagak Bay, AKDEC concluded that the Northern Victor Partnership facility *P/V Northern*
2 *Victor* produced seafood processing wastes (from Pacific cod, Pacific halibut, herring, walleye
3 pollock, salmon, and a variety of other fish) that created a waste pile deposit of settleable solid
4 residues measuring at least 2.4 acres in area and 7 feet thick on the seafloor. AKDEC concluded
5 that the waste pile exceeded Alaska's water quality standards for residues. For King Cove, the
6 AKDEC concluded that the Peter Pan Seafoods facility created a waste pile covering 11 acres of
7 seafloor to an average depth of 3 feet.

8
9 In 1998, the list of impaired waters that was prepared by the AKDEC included six additional
10 water bodies in Cold Bay, Dutch Harbor, and Kodiak that had been impaired by seafood
11 processing, logging operations, military materiel, or fuel storage. Although total maximum daily
12 loads for these facilities were not available for this biological opinion, the effects of these
13 facilities appear to be localized and would not be expected to adversely affect threatened or
14 endangered species under NMFS' jurisdiction.

15 16 **5.5.6.2 Indirect effects on Steller sea lions**

17
18 The discussion over the indirect, biological effects of the groundfish fisheries in Alaska S
19 specifically cascade effects and competitive interactions S and their potential impacts on non-
20 target species, has centered on the effects of the fisheries on the endangered western population
21 of Steller sea lions. There is general scientific agreement that the decline of the western
22 population of Steller sea lions results primarily from declines in the survival of juvenile Steller
23 sea lions, although the available evidence also indicates that reproduction in these sea lions has
24 been compromised. There is also general scientific agreement that the problems probably have a
25 dietary or nutritional cause. There is much less agreement on whether fishery-induced changes in
26 the forage base of Steller sea lions have contributed to and continues to contribute to the decline
27 of the Steller sea lion. However, as explained below, based on the best scientific and commercial
28 information available, the BSAI and GOA groundfish fisheries have likely adversely affected
29 Steller sea lions by (a) competing for sea lion prey and (b) affecting the structure of the fish
30 community in ways that reduce the availability of alternative prey.

31
32 In 1982, Lowry et al. provided a series of questions to assess competitive interactions between
33 fisheries and Steller sea lion: (a) does the subject fishery affect the diet of Steller sea lions? (b)
34 do any changes in diet compromise the condition of individual animals? (c) are any changes in
35 condition sufficient to reduce growth, reproduction or survival? and (d) are any changes in
36 reproduction and/or survival sufficient to have significant population effects? Unfortunately, the
37 data required to answer these questions are either unavailable or equivocal.

38
39 In the absence of unequivocal data, the debate about competition between groundfish fisheries
40 and Steller sea lions has continued since the Stellers' listing in 1991. The scientific community in
41 Alaska has conducted workshops (Alaska Sea Grant 1993, National Research Council 1996) and
42 published scientific papers (Loughlin and Merrick 1989, Alverson 1992, Trites and Larkin 1992,
43 Ferrero and Fritz 1994) without resolving the debate. Since 1991, the question of whether the
44 Alaska groundfish fisheries compete with Steller sea lions has been considered in annual
45 biological opinions NMFS has prepared on the fisheries. For example, on April 5, 1991, NMFS
46 issued biological opinions on the effects of the Alaska groundfish fisheries on endangered and
47 threatened species, including the Steller sea lion. The opinion recognized that the groundfish
48 fisheries could adversely affect Steller sea lions by (1) reducing food availability (quantity and/or
49 quality) due to harvest; (2) entangling them in fishing gear; (3) intentional harassment (including

1 killing and wounding) from fishermen; and 4) disturbance by vessels and fishing operations.
2 Nevertheless, the 1991 opinion concluded that the fishery was not likely to jeopardize the
3 continued existence and recovery of the Steller sea lion.
4

5 In 1998, NMFS prepared biological opinions on the walleye pollock fisheries in the BSAI and
6 GOA that concluded the fisheries were likely to jeopardize the continued existence of the
7 endangered western population of Steller sea lions and adversely modify critical habitat that had
8 been designated for the sea lions (NMFS 1998). In the absence of definitive data or conclusive
9 evidence, NMFS made the following assumptions to address the question of competition in the
10 1998 Biological Opinion on the walleye pollock fisheries:
11

- 12 1. The abundance of any species in a particular space at a particular time is finite.
13 Therefore, an activity that can remove hundreds of pounds in a single tow and thousands
14 of tons of fish per day must, on at least a very local scale and for short periods of time,
15 reduce the biomass of the targeted fish remaining in the ocean. By extension, it is
16 reasonable to assume that, as fishing effort increases or is concentrated in a particular
17 area in a specific period of time, the extent and duration of those reductions would
18 increase.
19
- 20 2. The likelihood of locally depleting a fish resource increases when that resource is
21 patchily distributed. That is, fish species are not homogeneously distributed throughout
22 the water column. Instead, there are specific areas that have larger numbers of fish and
23 other areas that have limited numbers of fish (Bakun 1996). Walleye pollock and Atka
24 mackerel are schooling fish that are patchily distributed: within a school their biomass is
25 very high while outside of a school their densities are low. Fishing effort that targets
26 schools of pollock or mackerel and removes a significant percentage of a school is likely
27 to reduce the biomass remaining in the ocean for at least a short period of time in a
28 particular space.
29
- 30 3. If these reductions in schools of pollock or mackerel occur within the foraging areas of
31 the endangered western population of Steller sea lions, the reduced availability of prey is
32 likely to reduce the foraging effectiveness of sea lions. The effects of these reductions
33 become more significant the longer they last and the reductions are likely to be most
34 significant to adult female and juvenile Steller sea lions during the winter months when
35 these animals have their highest energetic demands.
36

37 NMFS (1998) argued that these assumptions were reasonable and consistent with assumptions
38 made by others who had tried to resolve the issue of fishery effects on Steller sea lions (National
39 Research Council 1996). This would imply that pollock are effectively removed from some
40 areas at some time, and the local populations would probably take at least days or week to be
41 rebuilt by in-migration from elsewhere. It is thus possible that food shortage for some mammals
42 and birds - perhaps at crucial times and places for juveniles - have been exacerbated by this
43 intense pulse fishing.
44

45 NMFS has cited, as examples of localized depletions of walleye pollock possibly associated with
46 fishing effort, the Bogoslof Island area of the Aleutian Islands, the “donut hole” region of the
47 Bering Sea, and the Shelikof Strait in the GOA. Pollock were once abundant in these areas, were
48 heavily exploited by fisheries, and now consist of reduced stocks. While these stocks appeared to
49 have declined, in part, for natural reasons, exploitation appeared to have contributed to those

1 declines. NMFS (1998) cited Shelikof Strait as a more dramatic example of possible localized
2 depletion of walleye pollock (Fritz et al. 1995). A fishery developed after a large spawning
3 aggregation was discovered in the Strait in the late 1970s. Because of this fishery, pollock
4 catches in the GOA increased from less than 100,000 mt to more than 300,000 mt. By 1993, the
5 exploitable biomass of pollock in the GOA declined from 3 million tons in 1981 to less than 1
6 million (NPFMC 1993). The National Research Council (1997) concluded that “During this
7 same interval, sea lion counts on nearby rookeries showed a dramatic decline, and animals began
8 to show signs of reduced growth rate (Calkins and Goodwin 1988, Lowry et al. 1989).”
9

10 Based on these assumptions, NMFS’ 1998 Biological Opinion concluded that the pollock
11 fisheries in the BSAI and GOA were likely to jeopardize the continued existence of the
12 endangered western population of Steller sea lions and adversely modify critical habitat
13 designated for the sea lions. As a result of that opinion the debate about whether the Alaska
14 groundfish fisheries compete with Steller sea lions intensified.
15

16 NMFS’ 1999 Biological Opinion on the Alaska groundfish fisheries (for species other than
17 pollock and Atka mackerel), outlined some of the remaining uncertainties in the available data. It
18 argued that the amount of prey available is rarely known in the areas where sea lions forage, and
19 measures of harvest or total biomass for a larger area (i.e., total biomass in the BSAI region) may
20 or may not be good indicators of prey availability. For example, a large catch in a small area
21 may indicate that the prey available was severely reduced (creating poor conditions for sea
22 lions), or it may indicate that large amounts of prey were available (good conditions). If total
23 biomass estimates for a large region (i.e., the entire stock or some large subset of the entire stock)
24 are used as an index of availability, then spatial and temporal patterns of distribution must be
25 predictable or assumed constant over space. But observations of fishing distribution (Fritz 1993)
26 and survey results indicate that the patterns of the fishery and the distribution of fish may vary
27 considerably and, therefore, total biomass estimates may or may not be related to localized
28 biomass estimates.
29

30 NMFS’ 1999 Biological Opinion discussed potential competition between the fisheries and
31 Steller sea lions based on selection of prey by size, depth of prey, season of the fishery, and
32 nature of the interaction. These discussions are relevant to the issues evaluated in this biological
33 opinion and will be repeated below.
34

35 **Competition and selection of prey by size**

36
37 Size selection of prey by fisheries and by sea lions may have significant bearing on the
38 question of whether or not competitive interactions occur. Fisheries may compete with
39 sea lions if they remove the same size of prey from the same areas. Fisheries may also
40 reduce the spawning biomass of prey to the extent that the reproductive capacity of the
41 fish stock is reduced and, over time, fewer fish become available for sea lions.
42

43 The degree of overlap in the sizes of groundfish taken by Steller sea lions and by the
44 various groundfish fisheries is not known for most species, but it is reasonable to assume
45 at least some overlap occurs. The December 3, 1998 Biological Opinion provided
46 evidence that the size of pollock taken by the fishery and by sea lions overlaps.
47 Evaluation of the overlap is confounded by a number of factors. First, the sizes
48 consumed by sea lions are determined by the available prey and any preferential
49 selection of prey by size. In the majority of cases, scientists do not have sufficient

1 information to characterize the available prey and therefore can measure only what was
2 consumed, not necessarily what was preferred. Second, much of the information
3 presented in the scientific literature on sizes of prey taken by sea lions or fisheries has
4 been based on numbers taken by length. Inferences on relative importance of prey by
5 numbers taken by length are, however, misleading, as dietary value is determined by
6 biomass consumed by length, rather than number. That is, sea lions may gain a great
7 deal more nutrition from consumption of a single large prey item than from the
8 consumption of multiple small prey items and, therefore, number, is not the best
9 indicator of dietary value.

10 **Competition and depth of prey**

11
12
13 The possibility of competition between groundfish fisheries and the Steller sea lion has
14 been argued on the basis of depth of fishing, and depth of diving by sea lions. Overlap
15 by depth may occur for any of the species that occur and are taken by fisheries on the
16 shelf or shelf break. Competition may be less likely for species that tend to be found
17 deeper in the water column.

18
19 The extent to which competition between fisheries and sea lions may be avoided through
20 partitioning of resources by depth can be difficult to judge using the available
21 information. Scientific studies of sea lion foraging patterns are just beginning to
22 characterize the diving depths and patterns of sea lions, and they are likely capable of
23 foraging patterns not yet understood or anticipated. In addition, prey for sea lions and
24 fisheries move vertically in the water column as a function of life history traits,
25 geography, light levels, temperature gradients, and perhaps a range of other factors.

26 **Competition and the winter season**

27
28
29 Changes in behavior, foraging patterns, distribution, and metabolic or physiologic
30 requirements during the annual cycle are all pertinent to consideration of the potential
31 impact of prey removal by commercial fisheries. Steller sea lions, at least adult females
32 and immature animals, are not like some marine mammals that store large amounts of fat
33 to allow periods of fasting. They need more or less continuous access to food resources
34 throughout the year. Nevertheless, the sensitivity of sea lions to competition from
35 fisheries may be exaggerated during certain times of the year. Reproduction likely
36 places a considerable physiological or metabolic burden on adult females throughout
37 their annual cycle. Following birth of a pup, the female must acquire sufficient nutrients
38 and energy to support both herself and her pup. The added demand may persist until the
39 next reproductive season, or longer, and is exaggerated by the rigors and requirements of
40 winter conditions. The metabolic requirements of a female that has given birth and then
41 become pregnant again are increased further to the extent that lactation and pregnancy
42 overlap and the female must support her young-of-the-year, the developing fetus, and
43 herself. And again, she must do so through the winter season when metabolic
44 requirements are likely to be exaggerated by harsh environmental conditions.

45
46 Nursing pups are still dependent, at least to some extent, on their mother. If the mother
47 is able to satisfy all the pup's nutritional needs through the winter, then at least from a
48 nutritional point of view, winter may not be a time of added nutritional risk to the pup.
49 If, on the other hand, the pup begins a gradual transition to independence before or

1 during the winter season, then the challenge of survival may be greater for the pup
2 through the winter.
3

4 Weaned pups are independent of their mothers, but may not have developed adequate
5 foraging skills. They must learn those skills, and their ability to do so determines, at
6 least in part, whether they will survive to reproductive maturity. This transition to
7 nutritional independence is likely confounded by a number of seasonal factors. Seasonal
8 changes may severely confound foraging conditions and requirements; winter months
9 bring harsher environmental conditions (lower temperatures, rougher sea surface states)
10 and may be accompanied by changing prey concentrations and distributions (Merrick and
11 Loughlin 1997). Weaned pups' lack of experience may result in greater energetic costs
12 associated with searching for prey. Their smaller size and undeveloped foraging skills
13 may limit the prey available to them, while at the same time, their small size results in
14 relatively greater metabolic and growth requirements.
15

16 Diet studies of captive sea lions indicated that they adjust their intake levels seasonally,
17 with increases in fall and early winter months (Kastelein et al. 1990). These adjustments
18 varied with age and sex of the studied animals, and the extent to which the patterns
19 observed are reflective of foraging patterns in sea lions in the BSAI or GOA regions is
20 not known. Nonetheless, such studies support the contention that the winter period is a
21 time of greater metabolic demands and prey requirements.
22

23 Changes in condition, availability, and behavior of prey may also be essential to
24 successful foraging by all sea lions in winter. For example, pollock in reproductive
25 condition (i.e., bearing roe—toward the end of the winter) are presumably of greater
26 nutritional value to sea lions (for the same reasons that the fisheries would rather take
27 roe-bearing pollock than pollock spent after the spawning season). Also, the relative
28 value of any prey type must also depend on the energetic costs of capturing, consuming,
29 and digesting the prey. Prey spawning aggregations may lead to a reduction in sea lion
30 energetic costs associated with foraging. The characteristics of such aggregations may
31 determine their significance to foraging sea lions. Such characteristics likely include
32 their size, depth, location, composition, density, persistence, and predictability.
33

34 Nonetheless, the information that suggests that winter may be a crucial season for Steller
35 sea lions does not lessen the importance of available prey year-round. The observed
36 increases in consumption by captive animals in the fall months indicates that preparation
37 for winter months may also be essential. Spring may also be important as pregnant
38 females will be attempting to maximize their physical condition to increase the
39 likelihood of a large, healthy pup (which may be an important determinant of the
40 subsequent growth and survival of that pup). Similarly, those females that have been
41 nursing a pup for the previous year and are about to give birth may wean the first pup
42 completely, leaving that pup to survive solely on the basis of its own foraging skills.
43 Thus, food availability is surely crucial year-round, although it may be particularly
44 important for young animals and pregnant-lactating females in the winter.
45

46 **Interactive competition versus exploitative competition**

47

48 Much of the preceding discussion on the potential for competition between the Steller
49 sea lion and BSAI and GOA groundfish fisheries has focused on exploitative

1 competition; that is, competition that occurs when fisheries remove prey and thereby
2 reduce prey availability to sea lions. In addition to exploitative competition, fisheries
3 may affect sea lions through interactive competition. Examples of interactive
4 competition include disruption of normal sea lion foraging patterns by the presence and
5 movements of vessels and gear in the water, abandonment of prime foraging areas by sea
6 lions because of fishing activities, and disruption of prey schools in a manner that
7 reduces the effectiveness of sea lion foraging.
8

9 The hypothesis that these types of interactive competition occur can not be evaluated
10 with the information currently available. The only data are from the POP database, and
11 are not sufficient to describe the response of sea lions to fishing or other vessels. For
12 example, few observations of sea lions from fishing vessels could mean that a) sea lions
13 are present and tolerant of fishing but rarely sighted, or b) that sea lions are disturbed by
14 fishing vessels and therefore abandon areas that are being fished. Incidental catch of sea
15 lions in the 1970s and 1980s indicates that at least some sea lions were relatively tolerant
16 of vessels and fishing activities. On the other hand, such interactions are relatively rare
17 today, and it is possible there has been some selection for sea lions that avoid vessels and
18 fishing activities.
19

20 The effects of fishing on groundfish schools are not understood. Vessels fishing for
21 Atka mackerel trawl the same locations repeatedly, as they are unable to search for
22 schools (Atka mackerel don't have a swim bladder and therefore are not evident on fish-
23 finders). Analyses (Fritz, unpubl. manusc.) have shown that this repeated trawling can
24 lead to severe localized depletion. The number of schools affected and the effects on
25 schooling dynamics are not known, but these factors will be important in understanding
26 the overall impact of trawling for Atka mackerel on Steller sea lions.
27

28 Vessels trawling for other targets can use fish finders and are therefore able to search for
29 prey until they have found schools or aggregations of suitable density. The strategy used
30 is to continue to trawl that school (or set of schools) until such time as their size or
31 density is no longer sufficient to justify further trawling, and then to resume searching
32 until another aggregation of suitable density is located.
33

34 The strategies used by fishing vessels likely alter schooling dynamics and important
35 features of target schools: their number, density, size, and persistence. If sea lion
36 foraging strategies are adapted to take advantage of prey aggregations or schools, then
37 trawling may result not only in exploitative competition through removal of prey, but
38 also in interactive competition through disruption of schools or aggregations and their
39 normal dynamics. For example, the removal of a portion of a fish school by a trawl net
40 must create at least a temporary localized depletion (i.e., a gap in the prey school). How
41 long that gap persists and the responses of the remainder of the schooling prey to
42 trawling are unknown. The school may aggregate again, either quickly or over time, or it
43 may disperse. The short-term effects may be prolonged when trawling is repeated.
44 Hypothetically, it is possible that sea lions in the immediate vicinity of the trawled
45 school are able to take advantage of the disruption to isolate and capture prey. On the
46 other hand, sea lions have probably adapted their foraging patterns to normal schooling
47 behavior of their prey; trawling may disadvantage sea lions not only by removing their
48 potential prey within their foraging areas (exploitative competition), but also disrupting
49 the normal schooling behavior of the prey species. Other investigators have observed this

1 effect of fisheries on schooling species.
2

3 It is also important to note the potential cumulative effects of the Federal and state
4 fisheries on Steller sea lions. As discussed previously (in *Natural Change in the Action*
5 *Area*), walleye pollock clearly dominate the diets of Steller sea lions, although the sea
6 lions will prey on a variety of other species (see Table 5.2 and Fig. 4.5). Since the 1970s,
7 commercial fisheries for pollock has been focused within the foraging areas of Steller
8 sea lions, and has sufficient fishing power to locally deplete pollock schools or
9 disaggregate the schools (see the following section for more detail).
10

11 A predator faced with this kind of competitive pressure would normally shift its diet.
12 Steller sea lions, however, would then have to compete with fisheries for Pacific cod,
13 yellowfin sole, flatfish, Pacific salmon, herring, rockfish, etc. With each of these
14 potential prey, Steller sea lions would find competitive pressure caused by a reduction of
15 the biomass of a species and a change in its size structure and a local reduction caused by
16 fishing vessels in critical habitat for the sea lions.
17

18 All these phenomena singularly in or combination may have reduced the reproductive
19 success and population size of the western population of Steller sea lions in a way that
20 have reduced their likelihood of surviving and recovering in the wild. The available
21 evidence suggests that a significant part of the problem is the availability of prey.
22 Studies of animals collected in the GOA in 1975-1978 and 1985-1986 indicate that
23 animals in the latter collection were smaller, took longer to reach reproductive maturity,
24 produced fewer offspring, tended to be older, and exhibited signs of anemia — all
25 observations consistent with the hypothesis of nutritional stress (Calkins and Goodwin
26 1988, York 1994). In addition, the survival of juvenile animals has dropped in both the
27 eastern Aleutian Islands (Ugamak Island; Merrick et al. 1987) and the GOA (Marmot
28 Island; Chumbley et al. 1997). These results, the evidence of substantial changes in the
29 physical and biological features of the BSAI and GOA ecosystems, and the expansion of
30 fisheries in these regions all support the contention that lack of available prey has
31 contributed significantly to the past decline of the western population, and may still be so
32 contributing.
33

34 **5.5.6.2 Indirect effects on critical habitat for Steller sea lions**

35
36 Prey resources are not only the primary feature of Steller sea lion critical habitat, but they also
37 appear to control the maximum size of the Steller sea lion population. Therefore, the concepts of
38 critical habitat and environmental carrying capacity are closely linked: critical habitat reflects the
39 geographical extent of the environment needed to recover and conserve the species. The term
40 “environmental carrying capacity” is generally defined as the number of individuals that can be
41 supported by the resources available. The term has two main uses: first as a descriptive measure
42 of the environment under any given set of circumstances, and the second as a reference point for
43 the environment under “natural” conditions (i.e., unaltered by human activities). Thus, the
44 definition can have different implications depending on whether it is used to describe the
45 carrying capacity of an environment that is unaltered by humans or the carrying capacity of an
46 environment that has been altered by human-related activities.
47

48 The changes observed in the 1970s and 1980s in Steller sea lion growth, reproduction, and
49 survival are all consistent with limited availability of prey. One cannot distinguish the relative

1 effects of natural (i.e., oceanographic) phenomena from human-related activities (i.e., fisheries)
2 on the availability of prey for sea lions based on the scientific and commercial data available.
3 However, previous biological opinions have concluded that groundfish harvests in designated
4 critical habitat have reduced the availability of fish species that are important prey for Steller sea
5 lions. After considering all of the commercial fisheries that occur in the action area, especially in
6 areas designated as critical habitat for sea lions, and comparing those fisheries against the
7 various fish species consumed by Steller sea lions, we would conclude that commercial fisheries
8 would reduce the availability of Steller sea lion prey in designated critical habitat. Given the
9 magnitude of these harvests and their spatial and temporal extent, these removals could reduce
10 the availability of prey in critical habitat for Steller sea lions sufficient to reduce the habitat's
11 value to the sea lion population.
12

13 **5.5.6.3 Indirect effects on cetaceans**

14
15 The groundfish fisheries in the BSAI and GOA could indirectly affect endangered whales by
16 altering the trophic structure of the pelagic ecosystem, through cascade effects, and by competing
17 with them for food. However, the limited information on the biology, ecology, and demography
18 of endangered cetaceans in the BSAI, and GOA has made it very difficult to assess these
19 potential effects. In 1979, NMFS issued a biological opinion on the effects of the BSAI
20 groundfish fishery and the BSAI FMP on endangered cetaceans, that concluded that the BSAI
21 groundfish fishery was not likely to jeopardize the continued existence and recovery of these
22 cetaceans. Based upon the best scientific information available, the opinion concluded that none
23 of the 8 species of endangered whales in the BSAI would be adversely affected by direct
24 disturbance from or physical contact with groundfish fishing operations. Of the 8 species, the
25 opinion concluded that the fisheries were likely to compete with the fin, humpback, and sperm
26 whales. Because fin and humpback whale populations do not compete with the groundfish
27 fishery for their preferred food items, and because humpback whales are increasing, NMFS
28 concluded that no adverse impact has, or will, result from this small amount of competition.
29 Given the relative health of the sperm whale population in the North Pacific, and the relatively
30 small catch of squid species allowed by the FMP, NMFS concluded that sperm whales would
31 not be jeopardized by competition with the groundfish fishery.
32

33 NMFS has considered the effects of groundfish fisheries on endangered cetaceans in several
34 section 7 consultations since 1979, none of the biological opinions resulting from these
35 consultations concluded that the groundfish fisheries were likely to jeopardize the continued
36 existence of cetaceans in the BSAI, and GOA. At the same time, the absence of current
37 information on the biology, ecology, demography, status, and trends of endangered cetaceans in
38 the action area prevents these conclusions from being definitive.
39

40 **5.5.6.4 Indirect effects on salmon**

41
42 NMFS has no evidence to conclude that the commercial fisheries in the BSAI, and GOA
43 indirectly affect listed salmon.
44

45 **5.5.6.5 Indirect effects on leatherback turtles**

46
47 NMFS has no evidence to conclude that the commercial fisheries in the BSAI, and GOA
48 indirectly affect leatherback sea turtles.
49

1 **5.6 Impacts of Oil and Gas Development**
2

3 For almost three decades, oil and gas exploration, development, and production activities have been
4 associated with the State of Alaska. Since the 1970s, the Minerals Management Service has made blocks
5 of the Outer Continental Shelf off Alaska available for oil and gas leases; nine of those leases have
6 occurred in the action area for this consultation (see Table 5.11). Except for two active leases in lower
7 Cook Inlet, all of the leases have either expired or been relinquished.
8

9 On October 15, 1993, NMFS completed a biological opinion on the Cook Inlet lease sale (lease sale
10 Number 149), which concluded that the lease and associated exploration activities were not likely to
11 jeopardize the continued existence of any listed or proposed species, nor were they likely to destroy or
12 adversely modify critical habitats. That biological opinion recognized the proximity of the lease area to
13 important sea lion rookeries and haulouts in Shelikof Strait, the use of the Strait by foraging sea lions,
14 and its value as an area of high forage fish production, but recognized the low probability of oil spills
15 during exploration activities. In 1995, NMFS conducted another section 7 consultation with the Minerals
16 Management Service and concluded that the lease sale and exploration activities for the proposed oil and
17 gas Lease Sale Number 158, Yakutat were not likely to jeopardize the continued existence of any listed
18 or proposed species, nor were the activities likely to destroy or adversely modify critical habitats (NMFS
19 1995).
20

21 The State of Alaska also manages oil and gas leasing in the action area. In 1896, oil claims were staked at
22 Katalla approximately 50 miles south of Cordova. Oil was discovered there in 1902. An on-site refinery
23 near Controller Bay produced oil for over thirty years. The refinery burned down in 1933 and was not
24 replaced.
25

26 Exploration in Cook Inlet began in 1955 on the Kenai Peninsula in the Swanson River area, and oil was
27 discovered in 1957. Today, a number of active fields produce oil in Cook Inlet, all of which is processed
28 at the refinery at Nikiski on the Kenai Peninsula. Estimated oil reserves in Cook Inlet are 72 million
29 barrels of oil. Currently there are additional lease sales planned through 2005 for the Cook Inlet area, but
30 none for areas outside of Cook Inlet which would fall within the action area.
31

32 **5.7 Impacts of Research and Other Activities**
33

34 Steller sea lions have been killed for scientific research since the end of World War II (Thorsteinson and
35 Lensink 1962, Calkins and Pitcher 1982, Calkins and Goodwin 1988, and Calkins et al. 1994). In 1959,
36 630 sea lions bulls were killed in an experimental, commercial and provided life history information
37 (age, size, reproductive condition, food habits). Between 1975 and 1978, 250 sea lions were killed in
38 nearshore waters and on rookeries and haulouts of the GOA; their stomachs were removed and examined
39 for food content, reproductive organs were preserved for examination, blood samples were taken for
40 disease and parasite studies, body measurements were recorded for growth studies, skulls were retained
41 for age determination, tissue samples were preserved for elemental analysis and pelage samples were
42 taken for molt studies. In 1985 and 1986, 178 sea lions were killed in the GOA and southeast Alaska to
43 compare food habits, reproductive parameters, growth and condition, and diseases, with the same
44 parameters from animals which were collected in the 1970s. The study was designed to address the
45 problem of declining numbers of sea lions in the North Pacific and particularly in the GOA. More
46 recently, sixteen Steller sea lions were killed for a Natural Resources Damage Assessment study
47 following the Exxon Valdez oil spill.
48

49 For more than a decade, researchers have been conducting surveys and behavioral research on Steller sea

1 lions. The results of their annual studies suggest that Steller sea lion populations are not adversely
2 affected by this research, although individual animals may be adversely affected or killed. In 1998,
3 48,000 Steller sea lions were disturbed by these investigations, 384 pups were captured, tagged, and
4 branded, but there were no mortalities. In 1997, 31,150 Steller sea lions were approached by these
5 researchers, 14,550 were disturbed, 137 were captured, and 121 were tagged, but there were no known
6 mortalities. The studies conducted in 1996 had similar effects, although one Steller sea lions died during
7 the study (which equates to 0.002% of the animals approached or 0.007% of the animals disturbed). In
8 1995, 7,500 Steller sea lions were disturbed and none of them died.

9
10 Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable
11 effects on hauled-out sea lions ranging from no reaction at all to complete and immediate departure from
12 the haulout. When sea lions are frightened off rookeries during the breeding and pupping season, pups
13 may be trampled or, in extreme cases, abandoned. Sea lions have temporarily abandoned haulouts after
14 repeated disturbance (Thorsteinson and Lensink 1962), but in other situations they have continued using
15 areas after repeated and severe harassment. Johnson et al. (1989) evaluated the potential vulnerability of
16 various Steller sea lion haulout sites and rookeries to noise and disturbance and also noted a variable
17 effect on sea lions. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that
18 were subjected to repeated disturbance. A major sea lion rookery at Cape Sarichef was abandoned after
19 the construction of a light house at that site, but then has been used again as a haulout after the light
20 house was no longer inhabited by humans. The consequences of such disturbance to the overall
21 population are difficult to measure. Disturbance may have contributed to or exacerbated the decline,
22 although Federal, State, and private researchers familiar with the data do not believe disturbance has
23 been a major factor in the decline of Steller sea lions.

24 25 **5.8 Summary of Conservation Measures Taken Under the MMPA and the ESA for Listed** 26 **Species**

27
28 The following is a compilation of the conservation measures implemented by NMFS since the
29 development of the BSAI and GOA FMPs.

30 31 **5.8.1 Steller sea lions**

- 32
33 1. In 1989, the Environmental Defense Fund and 17 other environmental organizations petitioned
34 NMFS for an emergency rule listing all populations of Steller sea lions in Alaska as endangered
35 and to initiate a rulemaking to make that emergency listing permanent.
36
37 2. On April 5, 1990, NMFS issued an emergency interim rule (55 FR 12645) to list the Steller sea
38 lion as a threatened species under the ESA and established protective regulations as emergency
39 interim measures to begin the recovery process. The rule established the following:
40
41 • Monitoring of incidental take and monthly estimates of the level of incidental kill of
42 Steller sea lions in observed fisheries.
43
44 • Aggressive enforcement of protective regulations, especially as they relate to intentional,
45 lethal takes of Steller sea lions.
46
47 • Establishment of a Recovery Team to provide recommendations on further conservation
48 measures.
49

- 1 • Prohibition of shooting at or within 100 yds of Steller sea lions (this did not apply to
- 2 Alaska native subsistence hunting).
- 3
- 4 • Establishment of 3 nm “no-approach” buffer zones around the principle Steller sea lion
- 5 rookeries in the GOA and Aleutian Islands.
- 6
- 7 • Reduction of incidental kill quota from 1,350 to no more than 675 Steller sea lions.
- 8
- 9

10 3. On November 26, 1990, NMFS issued the final rule to list the Steller sea lion as threatened under

11 the ESA (55 FR 49204).

12

13 4. On January 7, 1991, NMFS issued a final rule to implement regulations to amend the BSAI and

14 GOA FMPs that limited pollock roe-stripping and seasonally allocated the pollock TAC in the

15 BSAI and GOA (56 FR 492). For BSAI fisheries, the pollock TAC was divided between an A

16 (roe) season and a B season (summer-fall). In the GOA fisheries, the pollock TAC for the

17 Central and Western (C/W) Regulatory areas was divided into 4 equal seasons. NMFS noted in

18 the proposed rule (55 FR 37907, September 14, 1990) that “shifting fishing effort to later in the

19 year may reduce competition for pollock between the fishery and Steller sea lions whose

20 populations have been declining in recent years”.

21

22 5. On June 19, 1991, NMFS issued an emergency interim rule to ensure that pollock fishing did not

23 jeopardize the continued existence or recovery of the threatened Steller sea lion (56 FR 28112).

24 The rule contained the following measures to protect Steller sea lions:

25

- 26 • Allocated the pollock TAC for the combined W/C Regulatory areas equally between two
- 27 subareas located east and west of 154°W,
- 28
- 29 • Limited the amount of unharvested pollock TAC that may be rolled over to subsequent
- 30 quarters in a fishing year, and
- 31
- 32 • Prohibited fishing with trawl gear in the EEZ within 10 nm of 14 Steller sea lion
- 33 rookeries.
- 34

35 6. On January 23, 1992, NMFS issued a final rule to implement amendments 20/25 to the BSAI and

36 GOA FMPs (57 FR 2683). This replaced prior emergency rules, and extended some of the

37 protections. The amendments contained the following protections:

38

- 39 • Prohibited trawling year-round within 10 nm of 37 Steller sea lion rookeries in the GOA
- 40 and BSAI,
- 41
- 42 • Expanded the no-trawl zone to 20 nm for 5 of these rookeries from January 1 through
- 43 April 15 each year,
- 44
- 45 • Established 3 GOA pollock management districts, and
- 46
- 47 • Imposed a limit on the amount of an excess pollock seasonal harvest that may be taken in
- 48 a quarter in each district.
- 49

- 1 7. On January 7, 1993 NMFS released the final Steller sea lion Recovery Plan. Section 4(f) of the
2 ESA requires that NMFS develop and implement plans for the conservation and survival of
3 endangered and threatened species. NMFS appointed a Steller Sea Lion Recovery Team to draft
4 the Recovery Plan in 1990. The draft Recovery Plan was released for public review and
5 comment on March 15, 1991. NMFS responded to comments received and provided notice on
6 January 7, 1993 that the final Recovery Plan was available (58 FR 3008).
7
- 8 8. On March 12, 1993, NMFS issued a final rule to implement a seasonally expanded no-trawl zone
9 around the Ugamak Island Steller sea lion rookery in the eastern Aleutian Islands during the
10 pollock roe fishery season in the BSAI (58 FR 13561). The expanded buffer zone around
11 Ugamak Island was expected to better encompass Steller sea lion winter habitats and juvenile
12 foraging areas in this portion of the southeastern Bering Sea shelf during the BSAI winter
13 pollock fishery.
14
- 15 9. On July 13, 1993, NMFS issued a final rule to implement regulations (BSAI FMP amendment
16 28) that subdivided the Aleutian Islands subdistrict into three subareas (Areas 541, 542, 543) (58
17 FR 37660). This action was taken because of concerns that concentrated fishery removals,
18 particularly Atka mackerel, in the eastern Aleutian Islands could cause localized depletions.
19 While dispersal of the Atka mackerel TAC was initiated to conserve fishery resources, it was
20 also consistent with the conservation objectives for Steller sea lions.
21
- 22 10. On August 27, 1993, pursuant to the ESA (§1533(a)(3)(A)), NMFS designated critical habitat for
23 Steller sea lions (58 FR 45269).
24
- 25 11. On November 1, 1993, NMFS initiated a status review of Steller sea lions to determine whether a
26 change in classification to endangered was warranted (58 FR 58318). NMFS solicited comments
27 and biological information concerning the status of Steller sea lions to be used in its review.
28
- 29 12. On November 29-30, 1994, NMFS convened the Steller Sea Lion Recovery Team specifically to
30 consider the appropriate ESA listing status for Steller sea lions and to evaluate the adequacy of
31 ongoing research and management programs. The Recovery Team recommended that NMFS list
32 the Steller sea lion as two separate population segments, split to the east and west of 144°W.
33 The Recovery Team recommended that the western population segment be listed as endangered
34 and the eastern population segment be listed as threatened.
35
- 36 13. On February 22, 1995, NMFS forward its recommendation to NMFS Headquarters to split the
37 Steller sea lion population east and west of 144°W, and to list the western population as
38 endangered. In October 1995, NMFS issued a proposed rule to list the western population of the
39 Steller sea lion as endangered.
40
- 41 14. On May 5, 1997, NMFS reclassified Steller sea lions as two distinct population segments under
42 the ESA (62 FR 24345). The population segment west of 144°W (near Cape Suckling, AK) was
43 reclassified as endangered, while the population east of 144°W was maintained as threatened.
44
- 45 15. On March 17, 1998, NMFS issued regulations to create a separate forage fish category
46 (Amendments 36/39 to the BSAI and GOA FMPs; 63 FR 13009). Directed fishing for forage
47 fish was prohibited at all times in Federal waters of the BSAI and GOA. The intended effect of
48 this action was to prevent the development of a commercial directed fishery for forage fish, a
49 critical food source for many marine mammal, seabird, and fish species.

- 1 16. On June 11, 1998, NMFS issued a final rule to reallocate pollock TAC in the W/C Regulatory
2 areas of the GOA by moving 10% of the TAC from the 3rd fishing season, which started on
3 September 1, to the 2nd fishing season, which started on June 1 (63 FR 31939). This seasonal
4 TAC shift was a precautionary measure intended to reduce the potential impacts on Steller sea
5 lions.
6
- 7 17. On January 22, 1999, NMFS issued a final rule to spatially and temporally distribute the Atka
8 mackerel TAC in the Aleutian Islands subarea. This was a precautionary approach to reduce the
9 probability of localized depletions of Atka mackerel inside Steller sea lion critical habitat. The
10 amendment implemented both spatial and temporal redistribution of the Atka mackerel TAC.
11
- 12 18. On January 22, 1999, NMFS published an emergency interim rule (64 FR 3437) implementing
13 the reasonable and prudent alternatives (RPAs) from the December 3, 1998 Biological Opinion
14 which concluded that the pollock fisheries as proposed were likely to jeopardize the continued
15 existence of the endangered western population of Steller sea lions and adversely modify its
16 critical habitat. The rule created (1) Temporal dispersion of fishing effort, (2) spatial dispersion
17 of fishing effort, and (3) pollock trawl exclusion zones around Steller sea lion rookeries and
18 haulouts.
19
- 20 On July 21, 1999, NMFS extended the emergency rule through December 31, 1999 (64 FR
21 39087), with revisions to include specifications for the B and C pollock seasons in the Bering
22 Sea.
23
- 24 19. In October 1999, NMFS conducted additional analyses of the RPAs and developed revised final
25 RPAs (RFRPAs) to be incorporated into the December 3, 1998 Opinion as compelled by a Court
26 Order. The RFRPAs provided a detailed set of alternative management measures that would
27 avoid the likelihood that the pollock fisheries would jeopardize the continued existence of the
28 western population of Steller sea lions or adversely modify its critical habitat. Season dates,
29 pollock catch percentages within critical habitat, and no pollock trawling areas were modified
30 from the original RPAs.
31
- 32 20. On January 25, 2000, NMFS published an emergency interim rule (65 FR 3892) implementing
33 the RFRPAs from the December 3, 1998, Biological Opinion as modified in October 1999. On
34 June 12, 2000, NMFS extended the emergency interim rule through December 31, 2000 (65 FR
35 36795).
36

37 **5.8.2 Salmon**

38

- 39 1. On November 29, 1995, NMFS published a final rule (60 FR 61215) which implemented
40 Amendment 58 to the BSAI FMP. This established annual prohibited species catch (PSC) limits
41 for chinook salmon and specific seasonal no-trawling zones that were triggered when bycatch
42 limits were reached.
43
- 44 2. On October 12, 2000, NMFS published a final rule to amend the BSAI FMP (58) to implement
45 modifications to the chinook salmon savings areas in order to reduce the overall bycatch amount
46 of chinook salmon (65 FR 60587).

6 EFFECTS OF THE FEDERAL ACTION

The federal action assessed in this opinion is the continued authorization of the BSAI and GOA groundfish fisheries under the existing FMPs, as amended. The FMPs provide the overarching guiding documents for the fisheries. As such, they determine the manner in which the fisheries are implemented, and thereby also determine the nature and magnitude of fishery effects on the BSAI and GOA ecosystems, and the listed species and critical habitat therein.

The purpose of this section is to analyze the effects of the action as described in Section 2. The scope of this analysis is intended to be comprehensive. The effects analysis will be broad and will examine the FMPs for federally managed fisheries in the GOA and BSAI, and the manner in which the total allowable catch levels are set as well as the process that leads to setting these levels. The analysis considers the direct and indirect effects of the FMPs and the effects of the fisheries prosecuted under the FMPs, on threatened and endangered species and critical habitat including the amount of prey biomass taken from sea lion critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

6.1 Analytical Approach

The analysis begins with some brief background, including information on the population dynamics of the target stocks and definitions of relevant terms. This information is essential for understanding the remainder of the section. The effects analysis is then divided into four main parts (6.3, 6.4, 6.5, and 6.6). Responses of listed species or the ecosystem to these effects are discussed in section 6.6. It is important to note that while much of this section describes the impact of fish management on fish stocks, ultimately the health and availability of the stocks are relevant to the condition of listed species.

The first part of the effects analysis (6.3) is a characterization of the fundamental elements of fishery management as practiced under the FMPs. A subset of these characteristics are particularly important sources of potential ecosystem effects and are highlighted in subsequent sections.

In the second part of this analysis (6.4), focus is on one of those characteristics in particular, exploitation strategies, because of their potential relevance, both past and present, in shaping changes in the abundance and population structure of groundfish stocks. The analysis presents as an example one of the present fishery management regime's maximum target fishing reference points of $B_{40\%}$ to illustrate the potential direction and intensity of direct effects. This regime employed for certain groundfish species, utilizes a target fishing mortality rate ($F_{40\%}$) which reduces the equilibrium spawning biomass per recruit of the target stock to 40% of its equilibrium unfished level (i.e. a 60% reduction). Differences exist in available data for determining these levels for the different fish species under the FMP (a tiered system is used), but the reference point strategy is the same.

The third part of this analysis (section 6.5) evaluates all the elements of the cycle that underlay management decisions (other than B_{40} above). This section steps through the annual fishery cycle, from surveys through the establishment of TACs, to the prosecution of fisheries as a means of presenting

1 analyses of several more important elements in chronological order. The effects are evaluated specific to
2 the major stages of the cycle and whether the effects can be compounded through subsequent steps in the
3 cycle.
4

5 Finally, the fourth part of this analysis (6.6) examines specific management elements, the FMPs as
6 guiding documents for management of the fisheries and protection of the associated ecosystems. Whereas
7 sections 6.2 & 6.3 focus primarily on the scientific foundations which underlay the management
8 decision, here we deal with management elements that incorporate the scientific foundations. Examples
9 of management elements that would be used in implementing the fisheries include access, fleet capacity,
10 gear types, and time/area closures. This analysis will include the fisheries that are prosecuted under the
11 FMPs, specifically, whether the FMPs, contain the conservation and management measures necessary to
12 reasonably ensure that the action directly or indirectly does not adversely affect threatened and
13 endangered species in a manner that appreciably reduces their likelihood of both survival and recovery in
14 the wild (jeopardy), or appreciably diminishes the value of designated critical habitat for both the
15 survival and recovery of threatened and endangered species in the wild (adverse modification).
16

17 **6.2 Background Information**

18 **6.2.1 Definitions**

19 In this section, the intent is to provide a brief review of several concepts in population dynamics that are
20 necessary to understand our terminology and subsequent analyses in this section. The following is a list
21 of working definitions:
22
23

24
25 **Stocks** — The term “stock” refers to a group of individuals that form a population unit with
26 some unifying characteristic. That characteristic may be based on biological information (i.e., a
27 genetic stock, or a group of individuals with similar genetic characteristics that separate them
28 from other individuals), or managerial (i.e., a GOA Pacific cod stock that may be genetically
29 inseparable from the BSAI cod stock but is managed separately because of geography, and for
30 the purpose of setting TACs). In this section, we use the term “stock” to mean a group of
31 individuals that form a management unit.
32

33 **Metapopulation** — The term “metapopulation” is used to indicate a “population of
34 populations.” That is, a metapopulation consists of multiple population units that are linked by
35 some level of individual exchange between subpopulations.
36

37 **Closed populations or stocks** — The term “closed” is used with respect to populations or stocks
38 to indicate that the population is effectively isolated from exchange with other populations. That
39 is, the dynamics of a closed population are determined by reproduction and mortality without
40 influence from immigration or emigration. Unless stated otherwise, we will assume that the
41 stocks or populations under consideration are closed.
42

43 **Replenishment** — In the absence of immigration, populations or stocks are “replenished” by
44 reproduction (addition to the number of individuals) and somatic growth (addition of mass to
45 existing individuals).
46

47 **Mortality** — In the absence of emigration, populations or stocks are reduced by mortality.
48 Natural mortality occurs from predation, disease, injury, etc. Fishing mortality occurs as a
49 consequence of fishing.

1 **Recruitment** — Recruitment can be defined as the number or biomass of fish added to some
2 portion of a population (i.e., the mature portion, the fished portion). Throughout this opinion,
3 recruitment has been used to indicate the number or biomass of fish added to the fished portion
4 of a stock through the processes of aging and somatic growth. Recruitment is generally
5 described in terms of cohorts or age classes, and the age of recruitment is defined as a set age.
6 The actual recruitment process may vary from these conventions, as fish grow at different rates,
7 and not all of the fish in an cohort are necessarily recruited at the same age. In general, the
8 process of recruitment is more easily assessed and used as a starting point for an age-structured
9 analysis of a population. The factors or processes that actually determine recruitment
10 (reproduction, larval and juvenile life histories and survival) are less well understood, and the
11 accounting processes involved in quantitative fisheries biology often start with the age of
12 recruitment.

13
14 **Age structure** — The fact that individuals of the target stocks live and reproduce over multiple
15 years means that the stocks are age-structured. That is, they have individuals of age 0 that were
16 just produced, age 1 that were produced one year previous, age 2, age 3, and so on. As these
17 individuals also are capable of living multiple years past the age of recruitment to the fished
18 portion of the population, this portion is also age-structured. Age-structure is an important
19 characteristic of these stocks, because it means that from the age of recruitment, cohorts are
20 subjected to fishing mortality (on top of natural and non-fishing anthropogenic mortality) year
21 after year until the cohort no longer persists. That is, the fact that these populations are age-
22 structured is a fundamentally important determinant of the impact of fisheries.

23
24 **Population dynamics of an unfished population** — When taken together, the above
25 information indicates some basic elements of a stock's population dynamics. Consider a
26 groundfish stock *without fishing* (Fig. 6.1a).

- 27 • Each year, a cohort or age class is produced through the process of reproduction.
- 28 • From the annual point in time in which reproduction is complete, the cohort can only
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 decrease in number through natural mortality (other non-fishing mortality is not
included). Natural mortality is depicted by the points in Figure 6.1a. Natural mortality
can be very high for young fish, but is generally treated as a constant from a certain age
(e.g., age 3 in Fig. 6.1a).
- Individuals in the cohort *increase in body size (biomass)* as a result of somatic growth.
Total biomass (histogram bars in Figure 6.1a) for each cohort increases until the growth
rate no longer keeps pace with losses due to natural mortality (about age 5 in Figure
6.1a).
- The age structure of an unfished stock, then, is a consequence of numbers of fish
produced annually, their somatic growth, and losses due to natural mortality. The age
structure can be depicted in terms of numbers per age class, or biomass per age class.
Biomass is the preferred presentation because value to fisheries and other predators is
best measured in units of biomass.

Now consider the stock structure *with fishing*

- Recruitment is an annual process whereby a new cohort is added to the fished part of the

1 stock. Recruitment to the fished part of the stock occurs when the fish have reached a
2 sufficient size (or age) to be taken in the fishery (depicted as age 3 in Figure 6.1a).

- 3
- 4 • Fishing mortality can only reduce the number and biomass of fish in a recruited age class
5 or cohort (Fig. 6.1b, c).
- 6
- 7 • Recruitment does not replenish older age classes that are diminished by natural mortality
8 or by fishing mortality (non-fishing anthropogenic mortality is not considered).
- 9
- 10 • Once an age class has recruited to the fishery, it is fished year after year without
11 replenishment other than that occurring through somatic growth.
- 12

13 **Localized depletion** — A reduction in prey availability that adversely affects the foraging
14 efficiency of a predator dependent on that particular prey field. We can also describe this factor
15 in terms of niche overlap. In the wild, it is rare that two predators rely on exactly the same prey,
16 often, there is substantial separation in time of capture, size taken, location, or many other factors
17 which allow the resource to be compartmentalized. For example, northern fur seals eat
18 substantially smaller pollock than do Steller sea lions. But, if for discussion they did rely upon
19 the same size of pollock, they would deplete prey for each other. If we think of the fishery as a
20 top level predator such as fur seals, sea lions, or whales then we can examine the extent to which
21 a fishery results in *competitive niche overlap* via localized depletions.

22

23 **Prey field** — Finally, we use the term “prey field” to refer to the environment that a particular
24 predator experiences during foraging. The prey field consists of individuals from multiple
25 age/size-structured prey populations (i.e., individuals of multiple groundfish stocks). The
26 availability of each prey type is a function of a range of factors including their standing biomass
27 in the foraging area, their behavior, their age/size-structure, and their life history.

28

29 **6.2.2 The fundamental characteristics of groundfish fisheries**

30

31 Section 2 outlines the MSA, the fishery management process, and the specific measures of the FMPs,
32 that shape the fundamental characteristics of the federally managed Alaska groundfish fishery. Assessing
33 the effects of this action requires looking at the functioning of these factors within the ecosystem. The
34 MSA and associated National Standards recognize the importance of an ecosystem view. Specifically,
35 the MSA and National Standard 1 establish optimum yield as the goal of fishery management and, by
36 definition, “optimum” must take into account the protection of marine ecosystems and ecological factors
37 (16 U.S.C. 1802(28)). The MSA uses the term “conservation and management” to refer to all the rules,
38 regulations, conditions, methods, and other measures which are required to maintain the environment and
39 which assure that irreversible or long-term adverse effects on fishery resources and the marine
40 environment are avoided (16 U.S.C. 1802(5)). MSA FMPs must contain necessary and appropriate
41 conservation and management measures that are consistent with any other applicable law (16 U.S.C.
42 1853(a)), including the ESA. One of the main purposes of section 7 of the ESA is to assess the impacts
43 of federal actions within the context of environmental baseline and cumulative effects—an ecosystem
44 concept. ESA also provides for protection of the critical habitats upon which endangered species and
45 threatened species depend (16 U.S.C. 1531). Though both the ESA and MSA address the ecosystem
46 concept, some of the specific methods used to comply with the MSA mandate are not identical to what
47 may be appropriate in the ESA context. For example, the fish mortality figured into fish stock
48 assessments considers successful predation on fish by animals like sea lions in determining removal
49 rates, but does not consider sea lion predation that was unsuccessful. This section will assess the FMPs

1 and the FMP process from the latter perspective.
2

3 **6.2.3 Other applicable law which effect the FMPs and their consequences** 4

5 Before NMFS can promulgate regulations to implement an FMP or allow a fishery operate according to a
6 recommendation from the NPFMC, NMFS conducts several reviews as required by Federal statutes.
7 Several federal laws – the National Environmental Policy Act of 1969, the Endangered Species Act of
8 1973, and the Essential Fish Habitat provisions of the MSA – require NMFS to evaluate the
9 environmental effects of fisheries before NMFS acts on a recommendation from the NPFMC. Together
10 these provisions require review that should identify the impact of the proposed actions on marine and
11 coastal ecosystems, threatened and endangered species, designated critical habitat, species that are
12 proposed for listing as threatened or endangered, and candidate species.
13

14 **6.2.3.1 NEPA review** 15

16 The National Environmental Policy Act (NEPA) has two principal purposes: it requires federal
17 agencies to evaluate the potential environmental effects of any major federal action they are
18 involved in planning or permitting and alternatives to that action and it informs the public of the
19 potential impacts of major federal actions and alternatives during the earliest planning stages of
20 those actions (42 U.S.C. 4321 *et seq.*). NEPA’s first purpose is intended to ensure that decision-
21 making officials in federal agencies make well-informed decisions about actions they are
22 considering by having documents that disclose the potential impacts of an action and alternatives
23 to that action. NEPA’s second purpose provides the public an opportunity to become involved in
24 and influence final decisions on federal actions.
25

26 **6.2.3.2 EFH consultation** 27

28 Pursuant to Section 305(b)(2) of the Magnuson-Stevens Act, Federal agencies must consult with
29 NMFS regarding any of their actions authorized, funded, or undertaken or proposed to be
30 authorized, funded, or undertaken that may adversely affect EFH. The EFH regulations at 50
31 CFR Section 600.920(g)(2) require that an EFH assessment must contain:
32

- 33 1. A description of the proposed action;
- 34 2. An analysis of the effects, including cumulative effects, of the proposed action
35 on EFH, the managed species, and associated species, such as major prey
36 species, including affected life history stages;
- 37 3. The Federal agency’s views regarding the effects of the action on EFH; and
38
- 39 4. Proposed mitigation, if applicable.
40
41
42

43 Protection of essential fish habitat is important in maintaining healthy fish stocks, and so
44 indirectly may benefit ESA listed species. If fish and protected species essential habitats
45 overlap, more direct benefits may be realized.
46

47 **6.2.3.3 ESA review** 48

49 The ESA provides a comprehensive program for conserving the critical habitat that supports

1 threatened and endangered species and for conserving the species themselves. Section 7
2 consultations, such as the consultation that resulted in this biological opinion, form part of the
3 core of ESA's program. Section 7 of the ESA contains several important provisions, but two of
4 those provisions are relevant to this consultation: the conservation provisions of section 7(a)(1)
5 of the ESA and the prohibitions against jeopardy and adverse modification of critical habitat
6 contained in section 7(a)(2).
7

8 Section 7(a)(1) of the ESA directs the Secretaries of Commerce and Interior to use their
9 authorities to further the conservation purposes of the Act (16 U.S.C. 1536). Section 7(a)(2) of
10 the ESA was described at the beginning of this biological opinion. NMFS has conducted
11 multiple internal section 7(a)(2) consultations on the BSAI and GOA groundfish fisheries (see
12 Table 1.1).
13

14 **6.3 Description of the FMP Process for Determining the Annual Groundfish Catch**

15
16 This section considers the effects of the annual fisheries cycle on listed species. We will use the pollock
17 fisheries as an example and relate them to the individual components of the cycle as they were described
18 in the Description of the Action (section 2).
19

20 **6.3.1 Biological information – groundfish surveys**

21
22 The purpose of the surveys is to estimate the abundance and age structure of groundfish species. This
23 information is essential to the determination of the annual harvest amount (TAC). Current surveys are
24 designed to provide information to manage groundfish harvests on a single species basis. To manage
25 groundfish harvests on a multi-species level much more information would be necessary beyond what is
26 currently collected.
27

28 Three types of surveys are currently conducted, including bottom trawl for shellfish and bottom fishes,
29 hydroacoustic or echo integration-trawl (EIT) for pollock , and longline for bottom fishes (e.g.,
30 sablefish) of the deeper waters of the continental shelf and slope. Summer bottom trawl surveys of the
31 eastern Bering Sea have been conducted annually since 1972, with the current standardized time series
32 beginning in 1979. These surveys follow a systematic grid of sampling stations. Triennial summer
33 bottom trawl surveys for the Aleutian Islands and the Gulf of Alaska began in 1980 and 1984,
34 respectively. In 1999 the GOA was changed from a triennial to a biennial bottom trawl survey. These
35 surveys are based on area and depth-stratified random sampling among a set of predetermined stations.
36 Annual winter EIT surveys were initiated in 1981 to study abundance of spawning pollock in Shelikof
37 Strait, and in 1988 to study pollock abundance in the vicinity of Bogoslof Island. Summer longline
38 surveys were initiated by Japanese scientists in 1979 to assess sablefish abundance over the upper
39 continental slope in the Gulf of Alaska. These surveys are now conducted by U.S. scientists, and have
40 been extended to the Aleutian Islands and the eastern Bering Sea slope, where they are conducted in
41 alternate years. Current surveys are as follows:
42

- 43 1. Summer bottom trawl surveys in the eastern Bering Sea,
- 44 45 2. Triennial and biennial summer bottom trawl surveys in the Aleutian Islands and GOA
46 respectively,
- 47 48 3. Summer longline surveys for estimation of sablefish abundance, and
49

1 4. Winter EIT surveys in the Bogoslof and Shelikof areas on an annual basis.

2
3 The following surveys may be initiated in the future:

- 4
5 1. Winter EIT surveys may be instituted to determine abundance of pollock in sea lion
6 critical habitat,
7
8 2. Summer EIT surveys may be initiated on an alternate year basis in the GOA and eastern
9 Bering Sea, and
10
11 3. Based on results of a bottom trawl slope survey this summer (2000), biennial slope
12 surveys may be initiated in the eastern Bering Sea.
13

14 Surveys are conducted to assess the abundance or biomass of stocks. In addition, they also provide
15 important information on age and sex composition, recruitment of young fish to the fished stock, length
16 and weight at age, reproductive status or condition, food habits, and other pertinent biological
17 characteristics. Assessment of each of these parameters may be affected by sampling variability,
18 measurement error, or systematic bias. Considerable effort is directed at minimizing measurement error
19 and bias, but sampling variability may still occur and must be evaluated and reported to provide an
20 indication of the confidence with which final parameter estimates may be. If this estimation procedure is
21 unbiased, then 68% of the time this interval also would be expected to enclose the true value for pollock
22 in the area assessed.
23

24 A principal concern of the survey design with respect to listed species is whether the timing and
25 frequency of the surveys, and the scale of the surveys, allow for biomass estimates that can be used to
26 assess potential competition at scales relevant to foraging listed species, especially Steller sea lions.
27 Survey information is used to spatially allocate TACs to management areas. Surveys in the GOA and AI
28 are used to allocate TACs in proportion to biomass. However, more frequent surveys would be necessary
29 in order to confidently allocate TACs in proportion to biomass in areas smaller than entire regions (e.g.
30 in areas smaller than GOA). Bottom trawl surveys in the GOA, for example, have historically been
31 conducted every three years. Results from the 1993, 1996, and 1999 surveys demonstrate the difficulty
32 of understanding the spatial/temporal dynamics of the pollock stocks in this region based on those
33 results.
34

35

Year	GOA-wide biomass estimate (mt)	95% confidence interval (mt)	Percent in area 610	Percent in area 620	Percent in area 630
1993	793,926	543,841 – 1,044,013	49%	25%	26%
1996	707,434	509,934 – 904,934	25%	42%	33%
1999	632,763	158,246 – 1,107,279	72%	18%	9%

36
37
38
39
40

41 The estimated portion of the stock in area 610 changed by almost 50% over a three-year period and the
42 change was in the opposite direction of that observed in the previous three years. These data may
43 represent actual changes in pollock distribution of the population, or they may reflect the magnitude of
44 the observation error in measurement of pollock biomass (e.g., large confidence intervals on the GOA-
45 wide estimates). The distribution of the stock in intervening years also can not be described. Thus, use

1 of the existing data to spatially allocate TAC in order to distribute catch in proportion to biomass is
2 problematic even for the seasons in which the surveys are conducted (summer). Spatial allocation of
3 TAC in winter has been more challenging since GOA-wide surveys have not been conducted in winter.
4

5 **6.3.1.1 Spatial limitations**

6
7 Tilman et al. (1997, p.3) wrote

8
9 “All organisms are discrete entities that mainly interact with neighboring individuals of
10 their own or other species. This discrete nature and spatial confinement is most evident
11 for sessile organisms. . . However, even motile organisms have their greatest impacts in a
12 rather confined region – the region through which they move. These simple observations
13 have profound implications for the dynamics and outcome of both intraspecific and
14 interspecific interactions. In particular, local interactions and local movement/dispersal
15 mean that population densities do not change in response to average conditions across a
16 large habitat, as is assumed in classical nonspatial models, but rather in response to the
17 local conditions experienced by each individual.”
18

19 Surveys cannot be conducted to provide relevant ecological information on all scales, but the
20 need for stock information on finer scales has recently become apparent. The prey removal and
21 the subsequent prey availability within critical habitat have been identified as an important issue
22 to be addressed. The lack of fine-scale survey information on the spatial distribution of the
23 stocks has made it difficult to distribute catch in proportion to biomass, even though distributing
24 catch in this manner has been identified as an important principle for management of these
25 fisheries. Recently, progress has been made toward estimating the biomass of key groundfish
26 species inside critical habitat on a monthly basis (NMFS 2000). This information will be used
27 to compare the monthly average per capita prey availability for Steller sea lions within critical
28 habitat with the monthly consumption estimates (see NMFS 2000). This comparison is
29 necessary to determine potential effects of competition between commercial fisheries and Steller
30 sea lions on the scale that is important to a foraging Steller sea lion. The results of this analysis
31 represent the best available scientific and commercial data. However, surveys conducted on
32 finer scales such as critical habitat or even smaller would be needed to better assess whether
33 there is sufficient prey inside critical habitat for Steller sea lions to forage without competitive
34 niche overlap with commercial groundfish fisheries.
35

36 **6.3.1.2 Temporal limitations**

37
38 Spatial limitations in the survey data are compounded by the lack of information on the seasonal
39 distribution of fish stocks. Even though the vast majority of the groundfish fisheries occur
40 during the winter/spring period, most of the groundfish stock surveys are conducted during the
41 summer. From limited surveys and tagging studies, we know that pollock and Pacific cod move
42 between spawning areas in winter (largely in critical habitat) and feeding areas in summer.
43 Efforts to estimate the magnitude of these migrations have used information from surveys
44 conducted at different times of the year (e.g., bottom trawl surveys in the summer, EIT surveys of
45 the GOA in the spring, and a few winter bottom trawl surveys in the EBS), fishery CPUE data
46 collected throughout the year, and tagging studies.
47

48 Information on groundfish stock distributions during the seasons when concentrated fishing
49 occurs is important in assessing the ecological effects of these removals. Without this

1 information, the potential interactions between the fisheries and listed species is difficult to
2 assess. The analytical approach described in section 6.4.3 and Appendix 3 (see also NMFS
3 2000) addresses the prey field of Steller sea lions on a monthly time scale and a spatial scale that
4 discriminates between biomass inside and outside of critical habitat for sea lions. Surveys
5 conducted on a temporal scale consistent with the needs of listed species such as Steller sea lions
6 (i.e, seasonal vs annual) would significantly reduce the uncertainty around seasonal or monthly
7 estimates of available biomass inside critical habitat.
8

9 **6.3.2 Stock assessment**

10
11 The purpose of stock assessment is to describe those stocks that are targeted by the fisheries and the
12 nature and magnitude of fishery effects on those stocks (i.e., the stocks' tolerance for fishing).
13 Consistent with the fundamental approach to fishery management, the primary objective of stock
14 assessments is to estimate biomass and the size-age structure of target stocks. The following paragraphs
15 we will describe the basic information necessary to understand the stock assessment process, and the
16 potential stock assessment process effects on a target stock and its associated marine community.
17

18 **6.3.2.1 Stock structure**

19
20 Research on stock structure for groundfish species is continuing (e.g., Bailey et al. 1999).
21 Currently, the best available information is based on limited tagging data for sablefish and
22 Pacific cod, morphometrics or genetic studies for pollock, Pacific ocean perch, Atka mackerel,
23 and a few other rockfish.
24

25 Pollock will be used in this section as an example to describe some of the patterns in stock
26 structure that have been observed in the past. Pollock in the BSAI are managed as three units:
27 eastern Bering Sea, Aleutian Islands, and the Aleutian Basin/Bogoslof Island (Basin).
28 Recruitment to the Basin stock is thought to occur primarily as density-dependent migration of
29 pollock from the eastern Bering sea shelf stock. Large cohorts of shelf pollock appear to be the
30 source of most of the pollock in the Basin, which suggests that the Basin stock itself is not self-
31 sustaining. Fishing on the Basin stock was terminated in 1992 by international agreement, but it
32 has since failed to recover. Given the reduced recruitment in the 1990s compared to the large
33 year classes in the late 1970s and 1980s, the Basin stock would have been expected to decline in
34 size even in the absence of fishing. The extent to which spawning in the Bogoslof region
35 contributes to recruitment of the shelf stock is unknown. For example, overfishing in the Basin
36 may have exacerbated the decline of the Basin stock, and it may have adversely affected
37 recruitment in the shelf stock.
38

39 Pollock stocks in the Aleutian Islands region have also declined since the mid-1980s, from a high
40 of 496,000 mt in 1983 to 105,000 mt in 1997 (Ianelli et al. 1999). Since the decline of pollock
41 in the Aleutians parallels that of the Basin, the two stocks may be closely related. Several
42 explanations for the lack of population recovery in the Aleutians might be explained primarily as
43 a series of years with poor recruitment. Ianelli et al. (1999) describe the pattern of pollock
44 fishing in the Aleutians in the 1990s, where the fishery moved increasingly westward apparently
45 because spawning aggregations in the eastern portion had disappeared (i.e. around Kanaga Island
46 and in Amukta Pass). It is not known whether spawning from these basin aggregations
47 contributed to the Aleutian stock (though it would seem likely that they did). The role that
48 fishing played in the lack of recovery in the area has not been evaluated.
49

6.3.2.2 Stock complexes

Under the FMPs, many stocks have been placed in complexes (e.g., groupings). Uncertainty is an even greater concern for species managed in complexes because they often are placed into complexes if the available information is insufficient to manage a species as a single target stock. The risk of fishery effects on a single species may be greater when the species is fished as part of a complex. Fishing mortality rates for complexes may be tolerable for more common or prolific species, but may not be tolerable for the more rare, slow-growing, long-lived species with relatively limited capacity for reproduction, recruitment, or recovery. For example, if a complex consists of three species, one with *natural mortality* (M) = 0.10, the second with M = 0.15, and the third with M = 0.20, and *Fishing Mortality* (F) is set for the whole complex based on either M = 0.15 or 0.20, then overfishing is likely for the species with M = 0.10. The only way to ensure that none of the species in the complex are subject to overfishing would be to set F on the basis of the lowest M . But M is unknown for many of the species in these complexes.

More than 144 stocks are incorporated into management complexes: GOA deepwater flatfish (3 spp.), GOA shallow-water flatfish (8+ species), GOA other slope rockfish (12+ spp.), GOA shortraker/rougheye rockfish, GOA pelagic shelf rockfish (4+ spp.), GOA demersal shelf rockfish (7 spp.), AI northern / sharpschin rockfish (2 spp), BSAI other flatfish (16 spp.), other rockfish (33+spp.), other slope rockfish (17 spp.), BSAI squid (multiple species), and AI shortraker /rougheye rockfish (2 spp.).

Some of the large complexes listed above (e.g., BSAI and GOA other species) are composed of a very diverse assemblage of species, some of which are prey for listed species (e.g., squid, octopus, and sculpins). While the magnitude of fishing effects on any single species in the other species assemblage is not thought to be large given the group catch amounts, the limited or non-existent information on the status or catch of any single species makes this determination uncertain. One example of precautionary management that addresses this is the establishment of retention thresholds for forage fish (e.g., osmerids and myctophids) to prohibit the establishment of new commercial fisheries. In general, the ecological consequences of fishing on groundfish complexes can not be evaluated due to the lack of data on the stock structure of individual species.

6.3.2.3 Stock distribution

As noted in the above description of stock surveys, information on the distribution of affected (fished and unfished) stocks is vital to assessment of fishery effects. The distribution of a species is an important determinant of the ecological role it plays in local marine communities, including availability to predators. This information is required to assess fishery effects on prey availability in Steller sea lion critical habitat. Recent opinions have identified a clear need for such information on the distribution of target stocks.

Better information on the spatial and temporal distribution of prey are needed to improve the assessment of whether the prey base under the current fishing regime is optimal in promoting the recovery of Steller sea lions. As noted in section 6.4.3 and Appendix 3 estimates of the spatial and temporal distribution of prey have recently been improved. However, the confidence intervals around these estimates remain fairly large.

6.3.2.4 Stock biomass

1 Biomass is used to describe or estimate stock status and trend, tolerance for fishing, and
2 reproductive capacity. Under the current harvest guidelines, a fishing mortality rate for a species
3 is set on the basis of its effect on target stock biomass and its reproductive capacity. That is, the
4 fishing mortality rate is intended to maintain the species at B_{MSY} or a proxy for it ($B_{40\%}$). Further,
5 the stock-recruitment relation fundamental to the MSY concept is based on recruitment as a
6 function of spawning biomass. Thus, stock biomass is clearly an important measure of the stock
7 and a basis for evaluating potential fishery yields.

8
9 Accurate estimates of stock biomass depend both on information from surveys and from the
10 fishery (total removals and catch age composition). Biomass estimates for the early years of the
11 pollock fishery are uncertain. Estimates of stock biomass for the early years of the pollock
12 fishery are uncertain because of limited and potentially biased information from both sources. In
13 the Bering Sea, the trawl survey began in the late 1960s, but the survey was initially designed to
14 survey crab populations and did not encompass the range of the pollock stock (Bakkala et al.
15 1985, Megrey and Wespestad 1990). In 1975, the survey was expanded to cover most of the
16 eastern Bering Sea shelf, and has been conducted annually since 1979. Catch information from
17 the foreign fishery during the 1970s was submitted by the fishing nations at bilateral meetings or
18 under provisions of the International Pacific Fisheries Commission. Since this was prior to the
19 development of fisheries observer programs, there was no way to verify the accuracy of the
20 catch information, and there were often questions about the credibility of some the reported
21 fisheries data (Megrey and Wespestad 1990).

22
23 Based on a most recent pollock assessment (Ianelli et al. 1999), pollock biomass in the 1970s
24 ranged from 2.0 mmt (million metric tons) in 1974 to 5.2 mmt in 1971 (Fig. 6.2, see also Table
25 1.14 in Ianelli et al. 1999). By contrast, Megrey and Wespestad (1990) reported that pollock in
26 the EBS ranged from about 8 mmt (million metric tons) to 12 mmt for the same time period. The
27 precision of the Ianelli et al (1999) estimates is depicted by the 95% confidence intervals in
28 Figure 6.2, which suggest that biomass in 1970s may have been as high 7.1 mmt (in 1971) or as
29 low as 1.1 mmt (in 1974). These estimates of uncertainty are only approximate and also rely on
30 assumptions of known natural mortality, relatively precise and unbiased total catch estimates and
31 correct model specification. Therefore, the actual variance is likely to be larger than that
32 indicated in Figure 6.2 (NRC 1996). Furthermore, fishery selectivity estimates from Ianelli et al.
33 (1999) were allowed to vary over time to reflect the fact that the fleet composition has changed
34 over time from foreign vessels to joint venture operations to the current domestic fleet. This
35 increases the overall variance of the model. Another effect of time-varying fishery selectivity
36 can change the interpretation of “available” biomass and simple exploitation rates comparing
37 total catch compared to age 3 and older biomass. For example, in 1974 about 23% of the
38 “available” biomass was aged 1 and 2. This was quite high and compares to an average of 3%
39 for the entire period 1964-1999. This is due to the fact that the 1972 year class was quite strong
40 and that the gear selectivity at that time was more concentrated on young pollock.

41
42 At present, biomass estimates or indices are available for 35 of the 39 species or species groups
43 listed in Table 2.7. This represents approximately 97% of the estimated total biomass. For
44 approximately 17 out of 35 of these stocks, biomass by age is not available. However, no
45 groundfish stock in the BSAI or GOA is currently being subjected to overfishing (a fishing
46 mortality rate higher than the maximum allowable rate) and regardless of the level of information
47 on each species, given an absence of a history of overfishing, it is unlikely that any stock would
48 be in an overfished condition defined using the single species criteria (biomass has fallen so low
49 that a special rebuilding plan is needed). Again, to address the question of whether harvests

1 based on imperfect biomass information for groundfish stocks affects listed species (for example
2 biomass estimates are not available for 4 of the 39 species in Table 2.7), it is important to go
3 back to the ecosystem concept and relate it back to foraging behavior of the listed species.
4 Material in section 4 describes the variability in fish species found in the diets of marine
5 mammals. The stocks for which the least information is available are the most lightly fished and
6 least abundant species. Therefore, the present inability to determine the status of certain stocks
7 is not likely to be a problem for listed species.
8

9 **6.3.2.5 Stock recruitment**

10
11 Recruitment is the only source of replenishment for the numbers of individuals in the fished
12 portion of a population. Biomass may be increased by somatic growth, but the biomass of a
13 cohort is also a function of the number of individuals in that cohort. Thus, recruitment can be
14 viewed as one process by which fished populations are maintained and their future status
15 assured. The factors and processes that determine recruitment have been a source of extensive
16 discussion and debate in fisheries biology. The debate has focused largely on two questions: (1)
17 is the process of recruitment density-independent or density-dependent, and (2) if density-
18 dependent, what is the nature of the relation between recruitment and stock size.
19

20 The regulations implementing the BSAI and GOA FMPs are based on the assumption that
21 recruitment is essentially a density-independent phenomenon. That is, environmental factors are
22 considered to be the principal determinants of the size of a recruited age class for the BSAI and
23 GOA groundfish stocks. Thus, the size of a recruiting cohort is independent of the size of the
24 stock that produced it (at least when the stock size is 20% of its unfished biomass). In addition,
25 recruitment is also assumed to be independent of time or year - i.e., recruitment does not exhibit
26 any trends over time. Examples of such trends would include increasing or decreasing
27 recruitment over time, increasing or decreasing variation in recruitment over time, or auto-
28 correlation (connectivity between points in time series).
29

30 The harvest policy, under the FMP, asserts that as long as a stock is maintained at or above a
31 minimal size ($\frac{1}{2} B_{MSY}$), recruitment will be unaffected and the stock is healthy. These policies are
32 based on a single-species approach to fisheries management designed to be precautionary.
33 However, if recruitment is a declining function of stock size (i.e., recruitment is more likely to be
34 small when stock size is small), or if recruitment is declining over time for other or unknown
35 reasons, then the population may be more likely to become overfished. We consider this
36 possibility in section 6.3.3 (below) on setting the TAC.
37

38 When spawner-recruitment relationships are uncertain, the F_{ABC} and F_{OFL} are based on estimates
39 of current stock status and considerations of spawning biomass per recruit. A designation of the
40 form " $F_{X\%}$ " refers to the F associated with an equilibrium level of spawning per recruit (SPR)
41 equal to $X\%$ of the equilibrium level of spawning per recruit in the absence of any fishing. The
42 use of SPR analyses to derive biological reference points for fisheries management has
43 undergone broad scientific review and is used to form the basis of harvest control rules in several
44 systems throughout the world (Clark, 1991; Clark, 1993; Thompson, 1993). The use of $F_{35\%}$, as
45 a proxy for F_{MSY} stems from the work of Clark (1991) who showed that a large fraction of the
46 potential yield from a typical groundfish stock could be obtained at a rate of $F_{35\%}$ across a
47 discrete set of plausible stock-recruitment relationships, including both Ricker and Beverton-Holt
48 forms. Subsequent analyses showed that $F_{40\%}$ would reduce the probability of low biomass if
49 recruitment was highly variable or autocorrelated (Clark 1993). Research continues to refine

1 our biological reference points. For example recent analyses have focused on considerations of
2 reproductive rates at low stock sizes (Myers et al. 1996) and applications of Clark’s general
3 approach to species that possess similar life history characteristics (Dorn In Review).
4

5 The concern for listed species that prey on fish is that if spawning-recruitment relationships are
6 uncertain, or if the recruitment is small when stock size is small, or if recruitment is declining
7 over time for other or unknown reasons, then the population may be more likely to be
8 unknowingly overfished, and prey availability reduced. However, the concepts discussed in the
9 above paragraphs show that NMFS has adopted a long-term harvest strategy based on general
10 principles of population growth that minimizes the risk of recruitment overfishing. The approach
11 expressly considers the need to maintain spawning stocks above some threshold and recognizes
12 the considerable interannual variability in recruitment resulting primarily from environmental
13 factors. Assessment scientists consider the influence of parameter selection within their models
14 to provide the best possible estimate of stock status. This is particularly true in the case of
15 assessments for important Steller sea lion forage species such as walleye pollock, Pacific cod and
16 Atka mackerel. The influences of key parameters such as natural mortality, on perceptions of
17 stock status are analyzed within the SAFE reports, but generally in a single species context.
18 Analyses include formally addressing uncertainty surrounding M using Bayesian meta-analysis
19 (e.g., Thompson et al. 1999) or attempts to formally address time trends in natural mortality by
20 key predators (e.g, Livingston and Methot 1998, Hollowed et. al. 2000). Therefore, the present
21 long-term harvest strategy minimizes the possibility of overfishing, and given the best available
22 information would not present a significant problem for species listed under the ESA in terms of
23 the total stock size and recruitment. Although, it would not control specifically for localized
24 depletions that could lead to unsuccessful foraging.
25

26 **6.3.2.6 Natural mortality**

27
28 Natural mortality (M) refers to the rate of decline of a fished stock as a consequence of natural
29 processes. These include predation by other fishes, marine mammals, and seabirds, as well as
30 some level of mortality due to disease, injury, starvation, etc. The relation between M and
31 fishing mortality (F) is an important consideration in the fishery management strategy.
32 Ironically, natural mortality is one of the most difficult parameters of a population to estimate.
33

34 Figure 22 in the BSAI FMP (p. 179; reproduced here as Figure 6.3), shows how mortality of
35 target (prey) species is partitioned among various users of that prey species. However, this
36 figure doesn’t capture the concept that other consumers may require certain prey densities to
37 meet their foraging needs. Adverse effects from a listed species point of view would occur if
38 foraging was not successful. These predators are challenged by “catchability” in the same
39 manner as the fishing fleet. “Catchability” is the part of the stock that is caught by a defined unit
40 of effort. The concept is well established in fisheries management, and well recognized in the
41 field of optimal foraging. While catchability by the fishery may increase with declining stock
42 size, prey availability for Steller sea lions will likely decrease, as discussed below.
43

44 The effect of reductions in prey biomass on other consumers in the environment has received
45 little treatment in traditional fisheries management. Sea lions, or other ecosystem consumers, do
46 not have the technological advantages of fishing fleets or the ability to change strategies, and
47 have limited physiological reserves to cope with declining availability. Adding fishing mortality
48 to natural mortality reduces the availability of prey to other consumers. When biomass reaches
49 a threshold, predators are no longer able to successfully forage for that prey, even if considerable

1 biomass remains in the system. This explains the fact that carrying capacity for these consumers
2 will go to zero before prey biomass in the system goes to zero. Thus, natural mortality of
3 target/prey stocks can not be partitioned as simply as the allocation portrayed in Figure 6.3
4 without consequences for the other consumers in the ecosystem. As far as effects on protected
5 species, overall biomass goals alone may not be as adequate for other consumers as it is for
6 fishermen. Availability implies things like spatial and temporal distribution in relation to the
7 predator, this would be important as well.
8

9 Models to estimate stock abundance and to make short-term projections of BSAI and GOA target
10 stocks are typically based on a constant natural mortality rate. These natural mortality rates are
11 usually estimated independently of the assessment model, and are based on published
12 correlations between M and more easily observed life history characteristics, such as the
13 maximum observed age or reproductive effort). Typically the results from several methods are
14 evaluated for consistency and to obtain a range for further analysis. Once a working value of M
15 is established, it is usually carried over from one assessment to the next to provide consistency in
16 management advice.
17

18 The estimation of natural mortality in fish stocks is far from constant, and this variability is
19 extensive enough that it should not be ignored. More analysis is generally required for within-
20 stock variability (both trends and variance) for exploited fish stocks. Most assessment scientists
21 would agree with this statement, and conduct such analysis whenever the necessary data are
22 available. For most stocks, however, the data are sufficient to support only a rough estimate of a
23 constant natural mortality rate for adult fish. Simulation and estimation trials for an age-
24 structured assessment model showed that even a constant natural mortality rate could not be
25 reliably estimated, with the possible exception of cases where the catch-at-age data extend back
26 to the beginning of the fishery. Assessment models can be used to evaluate the plausibility of
27 different values for M using techniques such as likelihood profiling (Hilborn and Walters 1992),
28 or by taking into account the uncertainty in M using Bayesian methods (see Thompson et al.
29 1999 and Sigler et al. 1999 for applications using Pacific cod and sablefish, respectively).
30

31 Multispecies assessment models (such as MSVPA) explicitly account for mortality by predators.
32 These models require additional assumptions concerning how species interact, and require
33 consumption estimates derived from stomach content sampling, which tends to be limited in
34 spatial and temporal scope and subject to potential bias (differential digestion rates, etc).
35 Typically these models show much higher juvenile mortality (Livingston and Methot 1998,
36 Livingston and Jurado-Molina 2000), but when the fishery takes larger fish than the predators,
37 the potential impact on short-term management advice is minor. However, when the fishery and
38 the predator take similar-sized fish (Hollowed et al. 2000), these models may produce
39 contradictory estimates of natural mortality of adult fish relative to those used in single-species
40 models, with corresponding uncertainty about management advice.
41

42 Stock assessment models are used to project these stocks based on the assumption of constant
43 natural mortality. In the case of BSAI and GOA groundfish, TACs are set each year at values
44 consistent with the harvest control rules and other provisions of the FMPs (e.g., the OY caps).
45 For some stocks in some years, this amounts to fishing at the maximum permissible ABC. In
46 such instances, the recommended fishing mortality rate typically varies directly with M . For
47 example, if the intent is to fish at a rate of $F_{40\%}$ and M happens to be over-estimated while all
48 other parameters are estimated without error, the recommended fishing mortality rate will exceed
49 the true value of $F_{40\%}$. However, over-estimation of M leads not only to errors in the estimate of

1 $F_{40\%}$ but to errors in the estimate of stock size as well. Errors in estimated stock size resulting
2 from over-estimation of M can be either positive (Thompson 1994) or negative (Thompson
3 1994). The combined effects of these two errors can result in a recommended short-term catch
4 that is either higher (Thompson 1994) or lower (Thompson 1994) than the short-term catch
5 corresponding to the intended harvest strategy. In the long term, however, catch tends not to be
6 sensitive to error in M except when gross under-estimates occur, in which case catches tend to be
7 lower than those corresponding to the intended harvest strategy. Because the relationship
8 between the estimate of M and the recommended catch is complicated, trends and variance in this
9 parameter are evaluated and the resulting uncertainty incorporated into the TAC setting process.
10 Stock assessment scientists typically pay special attention to this issue. Toward this end, SAFE
11 reports are required to address alternative estimates of M and its effects on model outputs.

12 13 **6.3.2.7 Uncertainty**

14
15 Uncertainty is inherent throughout the process by which TACs are set. The primary means by
16 which assessment uncertainty is conveyed is through the SAFE report. Assessment uncertainties
17 include both errors in observation (e.g., biomass estimates from surveys) and process errors.

18
19 One stock assessment modeling format used to assess some North Pacific groundfish stocks, AD
20 Model Builder, explicitly computes variance estimates on certain model outputs. An illustration
21 of the variance in one model output, yield, for the EBS pollock stock was presented by Ianelli et
22 al. (1999). Their Figure 1.26 (reproduced here as Fig. 6.4) indicates the uncertainty in expected
23 yield under three fishing mortality rates, F_{MSY} , $F_{40\%}$, and $F_{30\%}$. Under the $F_{40\%}$ regime, the mean
24 estimated yield was 1.013 mmt. The 50% confidence limits for this estimate, however, were 0.6
25 mmt and 1.7 mmt. The standard 95% confidence limits for the estimate were about 0.2 mmt and
26 some value greater than 3.0 mmt. These wide confidence limits suggest that yields are estimated
27 with uncertainty and this should be recognized by decision-makers, and incorporated into the
28 overall management approach. Further, the analysis points out that there is about a 30% chance
29 that harvesting at the point estimate for F would result in overfishing. Again, this analysis was
30 performed for EBS pollock, the stock for which we have the most information. We would expect
31 the uncertainty for other stocks to be even higher than for pollock. The use of modeling formats
32 that permit computation of confidence limits on model outputs is encouraged, as is the explicit
33 recognition of uncertainty in the setting of TACs.

34 35 **6.3.3 Setting the catch specifications (TAC)**

36
37 The process that determines TAC is a significant determinant of the magnitude of fishery effects on the
38 target species, listed species, critical habitat, and the ecosystems. The reductions in the biomass and prey
39 availability described earlier are a direct consequence of the TAC-setting process. That is, the long-term
40 reduction in standing biomass with all its ecological consequences follows directly from the catch in
41 accordance with the TACs. In this section, we focus on the effects of the TAC-setting process on the
42 target stocks themselves.

43
44 Recall from section 2 (Description of the Action) that the TAC setting process actually involves setting
45 an allowable biological catch (ABC) and an overfishing level (OFL) for a stock, together with an
46 evaluation of the stock's Minimum Stock Size Threshold (MSST). These values are determined or
47 evaluated first, with the intent of setting a catch target to achieve and a limit to avoid. That is, the first
48 part of the process is intended to identify the level of catch that allows the maximum yield while
49 protecting the target stock. The next step is to consider the ABC and OFL in the context of social,

1 economic, and ecological factors, and set the TAC accordingly.

2 3 **6.3.3.1 Theoretical framework and assumptions** 4

5 The TAC-setting framework established by regulations and applied in the management process is
6 considered sufficient to protect the target stocks from overfishing and from an overfished state
7 (as defined earlier). The framework adjusts the allowable harvest level for each stock based on
8 knowledge of the stock's status relative to its estimated status if it had not been fished. The
9 framework incorporates three operating principles: 1) the future status of each stock is
10 determined by recruitment, 2) the status of each stock can be reliably assessed, and 3) the harvest
11 rates established in the framework are sufficiently precautionary to protect the target stocks.
12

13 The theoretical framework for setting catch levels is illustrated in Figure 6.5. The Y axis in the
14 figure is fishing mortality rate (F). ABCs and OFLs are based on fishing mortality rate, which is
15 determined as a function of the status (biomass) of each target stock. For the majority of stocks,
16 ABC is based on an $F_{40\%}$ rate (i.e., would reduce the spawning biomass to 40% of its unfished
17 level) and OFL is based on an $F_{35\%}$ rate (would reduce the spawning biomass to 35% of its
18 unfished level). The X axis in Figure 6.5 is the biomass (B), and points on the X axis include the
19 biomass of the target stock as projected under a no-fishing scenario (B_{NF}), B_{MSY} , $\frac{1}{2} B_{MSY}$, and
20 $0.05B_{MSY}$. If a harvested stock is above B_{MSY} (tiers one and two) or its risk-averse target biomass
21 level, $B_{35\%}$ (tier three), then the recommended fishing mortality rate is set to achieve $F_{40\%}$ (or
22 reduce the stock to $B_{40\%}$). If the stock is between B_{MSY} and $\frac{1}{2} B_{MSY}$, then the stock is simulated to
23 determine whether it is overfished. If it is overfished, then a rebuilding plan is required within
24 one year. If it is not overfished, then the fishing mortality rate is still lowered in a linear fashion,
25 as indicated in Figure 6.5. If the stock is below $\frac{1}{2} B_{MSY}$, the fishing mortality rate is reduced
26 (again, linearly), the stock is declared overfished, and a rebuilding plan is required. As described
27 below, this framework cannot be applied to stocks in tiers 4 to 6.
28

29 **6.3.3.2 Random recruitment** 30

31 Short-term stock projections and estimation of $B_{40\%}$ are performed using estimates of recruitment.
32 In the absence of a discernible stock-recruitment relation or a temporal trend in the recruitment
33 data, recruitment is modeled as a randomly generated number from a stationary distribution
34 constructed from estimates of previous recruitment (over a specified range of time). If
35 recruitment is a function of spawning biomass, or exhibits a declining trend over time, then this
36 assumption of random recruitment independent of stock biomass over the observed time period
37 may be violated. The consequences of such a violation may be an increase in the level of
38 conservatism afforded by the harvest control rules. For example, if recruitment varies directly
39 with stock size and most estimates of recruitment come from stock sizes in excess of $B_{40\%}$, the
40 level of recruitment at $B_{40\%}$ will be over-estimated, thereby causing $B_{40\%}$ itself to be
41 overestimated, which in turn will cause the current stock size to appear lower relative to $B_{40\%}$
42 than is actually the case.
43

44 To test these two assumptions we examined stock-recruitment relationships and conducted time
45 series analysis for the 17 stocks for which recruitment data was available. Stock-recruitment
46 relationships were examined using data from 1985 to 1999 (Figs. 6.6 and 6.7) and, indeed, for
47 many of the target stocks, the evidence does not indicate a strong or obvious drop in recruitment
48 with declining spawning stock biomass. For some stocks, the evidence is even to the contrary.
49 However, for two stocks, BSAI Greenland turbot (Fig. 6.6 - Turbot) and GOA Pacific cod (Fig.

1 6.7), the data do give some preliminary indication that recruitment may vary directly with stock
2 size over the observed range. It is important to remember, though, that apparent correlations
3 between stock and recruitment can be deceptive due to the time series nature of the process, and
4 that estimates of the slope obtained from plots such as those shown in Figs. 6.6 and 6.7 tend to be
5 biased.

6
7 With respect to time-series analyses of recruitment levels, two tests for stationarity in the data
8 were conducted (i.e., to test the assumption that recruitment can be modeled as though it were
9 drawn randomly from a stationary or fixed distribution). The recruitment series are plotted in
10 Figures 6.8 and 6.9, and the results are listed in Table 6.1. The tests suggested that the null
11 hypothesis of stationarity could be rejected while the null hypothesis of non-stationarity could
12 not be rejected for the following stocks: EBS yellowfin sole, EBS arrowtooth flounder, EBS
13 rock sole, BSAI/GOA sablefish, AI Atka mackerel, GOA arrowtooth flounder, and GOA Pacific
14 ocean perch. Conversely, the tests suggested that the null hypothesis of non-stationarity could be
15 rejected while the null hypothesis of stationarity could not be rejected for the following stocks:
16 EBS Greenland turbot and GOA pollock. The tests suggested that neither the null hypothesis of
17 stationarity nor the null hypothesis of non-stationarity could be rejected for the following stocks:
18 BSAI Pacific cod, BSAI Alaska plaice, AI Pacific ocean perch, GOA Pacific cod, and GOA
19 thornyheads. Paradoxically, however, the tests suggested that *both* the null hypothesis of
20 stationarity *and* the null hypothesis of non-stationarity could be rejected in the case of EBS
21 Pacific ocean perch, indicating that the proper interpretation of these tests may require further
22 study.

23
24 Violations of the assumption that recruitment can be modeled as a random draw from a stationary
25 distribution could lead to overestimation of expected future recruitment and an underestimation
26 of vulnerability to continued fishing. If recruitment is a function of stock size, or if it exhibits a
27 declining trend over time, then the stock may not be sufficiently protected under the existing
28 management scheme. Recall that the status of each stock is evaluated annually relative to its
29 estimated unfished level (B_{NF}). Recall also that B_{NF} is estimated by applying constant values for
30 somatic growth and natural mortality to observed recruitment for each age class, and then
31 summing the expected biomass of each age class for the year in question. Importantly, B_{NF} is a
32 function of recruitment under this approach. If recruitment is declining for any reason (e.g., as a
33 function of stock size or some unexplained temporal trend), then B_{NF} will also decline. Thus, the
34 standard by which stock status is determined could decline as the stock itself declines. The case
35 of Greenland turbot illustrates the potential for such a “sliding” standard. For this stock,
36 recruitment has declined over time (Fig. 6.10a) in a fashion that appears to be related to stock
37 size (Fig. 6.10b). Estimated values of B_{NF} for this species have also declined over time, so that
38 the ratio of the stock biomass to B_{NF} has remained unchanged in spite of a significant decline in
39 the stock biomass over the past 15 years (Fig. 6.10c). That is, the status of Greenland turbot has
40 been determined by comparing the size of the stock with a standard that declines with stock size.
41 Thus, it appears that, at least for some stocks, recruitment may not be reliably and accurately
42 modeled as a random draw from a stationary distribution based on previous observations.
43 Therefore, the existing management strategy may not be sufficiently protective in those cases
44 where recruitment exhibits a pattern as a function of stock size or time.

45
46 Any model of a phenomenon as complex as fish recruitment will always omit some causative
47 factors. The question is whether the effect of such omissions (as described above) carries
48 significant risk for listed species. For some stocks where recruitment is a function of time or
49 stock size, current models may not be risk-adverse and might lead to a possible overestimation of

1 recruitment. There is general scientific agreement that the use of a random, stock-independent
2 process to model short-term future recruitment does not carry significant risk for single-species
3 groundfish management. These errors might be important if they involved stocks important to
4 the survival and recovery of listed species. However, the level of risk would have to be
5 evaluated in light of the ecosystem as a whole. As noted these errors would only potentially
6 occur for some stocks with certain characteristics, and listed species under consideration in this
7 opinion forage on multiple species. Again, the important question is not whether these modeling
8 efforts are adequate for their intended purpose in fishery management, it is whether these efforts
9 affect listed species in terms of the spatial and temporal availability of prey resources.

11 **6.3.3.3 Target harvest rates**

12
13 The TAC-setting framework establishes $B_{40\%}$ as a reference point in defining the maximum
14 permissible value of ABC. Stocks above that level may be reduced through harvesting. Stocks
15 below that level may still be harvested, but at reduced rates to allow the stock to recover over
16 time to a level considered safe. As they are written, the regulations would allow for a stock to be
17 harvested until it reached 2% of its unfished level. On the surface, this approach would appear to
18 not be sufficiently precautionary to assure that fish stocks are adequately protected from
19 overfishing. This could unknowingly result in a reduced prey availability to other predators
20 including listed species. However, the overall management approach does include checks to
21 reduce the probability that a stock will reach such a low level. Particularly, catch would fall
22 almost quadratically with spawning biomass, meaning that catch would be constrained to a very
23 small level long before a stock fell to 2% of its estimated unfished level. At present, no stocks in
24 tiers 1-3 have come anywhere close to the 2% level in the history of the FMPs. However it is
25 possible to reach that level, indicating that as far as the FMP process, potential effects on ESA-
26 listed species that are in competition for the target species may warrant a more conservative limit
27 for how low a stock can theoretically fall.

28
29 Stocks in tiers one to three can be evaluated with respect to the reference points in Figure 6.5
30 (B_{MSY} , or the proxy $B_{40\%}$, $\frac{1}{2} B_{MSY}$, and $0.05B_{MSY}$). None of these values can be estimated for stocks
31 in tier four. Thus, the status of stocks in tier four can not be determined relative to an unfished
32 level, nor can they be determined relative to their MSST.

33
34 Stocks in tier five can not be assessed with respect to their unfished level or their MSST. These
35 stocks can be harvested at an F_{ABC} of $0.75 * M$. To evaluate the potential effect of this strategy on
36 a tier 5 stock, an example was developed using an M value of 0.3, age of recruitment of three,
37 and a growth schedule consistent with pollock (Ianelli et al. 1999). Harvesting at $F = M * 0.75$
38 would reduce the spawning stock biomass to about 50% of its unfished level under this scenario.
39 The intent of the guidelines for tier five was to approximate the $B_{40\%}$ strategy, based on the idea
40 that harvesting at $F=M$ would produce $F_{30\%}$. On that basis, the guidelines for tier five also do not
41 appear to be precautionary as they aim at the same harvest level on the basis of less information.

42
43 Stocks in tier six also can not be assessed with respect to their unfished level or their MSST.
44 Only one stock, squid, falls into tier six. The tier 6 guidelines suggest that the OFL should be set
45 at the mean catch from 1978 to 1995, unless an alternative (unspecified) level is set by the
46 Council's SSC. The ABC level is then set at $0.75 * OFL$. While these guidelines would not
47 necessarily insure the protection of a stock in tier 6, catches of squid in the BSAI and GOA (less
48 than 2,000 mt in 1999) are relatively low compared to squid biomass estimates based on
49 predation models in the eastern Bering Sea (Sobelevsky 1996). The guidelines are based on the

1 assumption that a stock that has tolerated a certain mean level of catch can continue to tolerate
2 that level (or that level times 0.75) indefinitely. While in general, these harvest guidelines may
3 not be sufficiently precautionary to assure that stocks in tier six are adequately protected, the
4 only stock currently in tier six, squid, does not appear to be overfished.
5

6 **6.3.3.4 Consideration of ecological factors**

7

8 The MSA and resulting regulations require that relevant social, economic, and ecological factors
9 be considered in the setting of optimum yield for a fishery. The regulations (50 CFR § 600.310
10 (f)(3)(iii)) provide the following examples of ecological factors:

11 “stock size and age composition, the vulnerability of incidental or unregulated stocks in a
12 mixed-stock fishery, predator-prey or competitive interactions, and dependence of
13 marine mammals and birds or endangered species on a stock of fish. Also important are
14 ecological or environmental conditions that stress marine organisms such as natural or
15 manmade changes in wetlands or nursery grounds, and effects of pollutants on habitat
16 and stocks.”
17

18
19 The BSAI FMP notes that the implementation of the fishery management plan does not cause
20 adverse impacts on the environment. The FMP states (p. 1):

21 “Implementation of this fishery management plan within the limit of its constraints is
22 presumed not to cause adverse impacts on the environment. Conservation measures are
23 provided for species for which they are deemed necessary. Those measures and the
24 conduct of the fishery as outlined will be beneficial to the ocean environment affected, to
25 demersal and pelagic fishes, and to the human environment.”
26
27

28 Thus the FMP process considers the species managed under it as parts of functioning
29 ecosystems. However, ecosystem management is extremely complex. In setting the harvest rate,
30 managers also attempt to be sufficiently protective of the larger ecosystem in which the
31 harvesting occurs. An Ecosystems Considerations section has been added to the SAFE
32 documents since 1995. However, it is unclear how the SAFE authors identify the uncertainty
33 inherent in ecosystem analyses discussed above or how they incorporate that information into the
34 management process. For example, it is unclear how the 25% (BSAI Atka mackerel) to 60%
35 (BSAI pollock) reduction in spawning biomass per recruit of target stocks was incorporated into
36 the SAFE report. Section 7 of the ESA allows for a dynamic process to continually re-evaluate
37 strategies to further minimize the impacts of human activities on listed species. An expanded
38 discussion of the possible ecosystem effects of fishing is discussed in section 6.5.3.
39

40 **6.3.4 Implementation of the fishery**

41

42 The potential direct and indirect effects of fisheries on the marine ecosystem vary considerably by
43 access, fleet capacity, time/area management measures and gear type employed in the fishery. The
44 primary effects are related to spatial and temporal dispersion of the catch, and the effects on habitat by
45 depleting prey, interfering with other consumers including Steller sea lions, and physically altering
46 bottom habitat. These effects are of concern for listed species and critical habitat designated for Steller
47 sea lions.
48

49 **6.3.4.1 Access to the fisheries**

1 Access to the fisheries determines the number of participants and the nature of competition
2 among fishery participants for the catch. The catch is available to all participants until the TAC
3 is caught and the fishery must be closed. The result is a competitive “race for fish” that
4 emphasizes fishing capacity and speed, and increases the likelihood of temporal and spatial
5 concentration of catch. This discourages selectivity of catch (i.e., searching for the best
6 conditions to enhance product quality and avoid adverse effects), deters temporal and spatial
7 dispersion of catch, and reduces emphasis on fishing efficiency. It also potentially increases
8 risks to the safety of fishery participants by creating an incentive for small vessels to fish under
9 adverse conditions if they wish to compete for the catch. With regards to Steller sea lions it
10 requires a compressed fishing schedule, often in space and time, that has the potential to locally
11 deplete prey availability to foraging sea lions.

12
13 Some alternatives to traditional processes include license limitation programs (which limit the
14 number of participants), cooperatives (that may disperse catch among members so that they can
15 operate without the constraints of the race for fish), and individual fishery quota systems (that
16 establish or distribute individual quotas among a limited number of fishery participants so that
17 they may devise the best method of fishing without the need to compete for a limited catch).
18 These alternatives are generally referred to as forms of rationalization of the fisheries, and have
19 been applied to the sablefish fishery and, to some degree, to the BSAI pollock fishery (through
20 cooperatives allowed under the American Fisheries Act of 1998). It seems clear that
21 cooperatives following the implementation of the AFA (see discussion in section 5) resulted in a
22 decrease in adverse impacts on the western population of Steller sea lions. The pollock fishery
23 was not only slower in the BSAI in 1999 and 2000 due to AFA, it also employed fewer boats and
24 had less discards. Methods that encourage fishermen to work together to solve these problems
25 on a voluntary basis have promise and are often superior in situations where enforcement is
26 difficult.

27 28 **6.3.4.2 Fleet capacity**

29
30 The capacity of a fishery fleet determines the rate at which the catch can be taken, but also
31 determines the economic burden of fishing that must be balanced by fishery income to make a
32 profit and stay in business. The existing BSAI and GOA fleets currently exceed the minimum
33 capacity required to catch the TACs. As a consequence, daily catch rates are high and some
34 fisheries last only a matter of days (or even hours). This race for fish results in a temporal
35 concentration of catch (e.g., GOA pollock), increased pressure to maximize catch quotas,
36 increased risk of environmental effects, and increased risk to the safety of fishery participants.

37
38 The number of vessels (and their harvesting capacity) influences the removal rate of groundfish
39 in the BSAI and GOA. The number of vessels participating in groundfish fisheries in the GOA
40 dropped from 1,571 in 1994 to 1,140 in 1998. However, it is difficult to equate this directly with
41 effort because a number of the small boats were replaced by larger vessels. Overall, the tonnage
42 of vessels in the GOA dropped from about 84,000 in 1994, to 67,500 in 1998. In the BSAI, 337
43 vessels participated in the groundfish fishery in 1998, about the same amount as in 1994. The
44 fleet consists of much larger vessels than in the GOA.

45
46 Vessel size or processing capacity may affect the location and timing of the catch of groundfish.
47 Larger vessels are more able to fish offshore, outside of critical habitat because of increased sea
48 worthiness, ability to process fish, and extended crew carrying capacity. Small vessels, such as
49 the GOA fleet, are limited to coastal areas (often inside critical habitat for Steller sea lions),

1 which may increase competitive interactions between commercial fisheries and Steller sea lions.
2 However, it would be possible to mitigate some of this effect through allocation strategies. For
3 example, limited available TAC inside critical habitat could be allocated only to smaller vessels,
4 because larger vessels are capable of fishing safely farther from shore.

6 **6.3.4.3 Gear types authorized by the FMPs**

7
8 The various gear types used in these fisheries (trawl, pot, hook-and-line, and jig) have
9 differential effects on the environment. Table 6.2 reviews some considerations pertinent to the
10 assessment of gear type effects. The table clearly indicates that trawl fishing is the dominant
11 gear in these fisheries, accounting for 86% of the catch in the BSAI and 73% in the GOA. In the
12 BSAI, annual allocations are generally specified by gear type whereas in the GOA, most of the
13 fisheries are open to the vessels using any gear type based on license limitation programs only.

14
15 The possible effects on bottom habitat by various gear types is presently being investigated, with
16 most of the research on habitat effects focused on bottom trawl gear effects on benthic substrate
17 and communities. For trawl gear, current studies have shown that the use of benthic gear reduces
18 biodiversity and habitat complexity in trawled areas (Auster and Langton, 1999) but the long-
19 term effects, if any, are unknown. About half of the fish harvested in the BSAI and GOA is with
20 pelagic gear, which generally does not come in contact with the bottom. Little research has been
21 conducted on hook-and-line or pot gear effects, which clearly limits our ability to describe the
22 possible impacts by those gear types. We know that such fixed gear does, in fact, affect the
23 bottom, snagging on corals, dislodging, or compacting other objects (anecdotal information), but
24 the significance of these effects can not be quantified on the basis of the current information.
25 These effects are the subject of a comprehensive examination of the effects of fishing on habitat
26 that are contained in an SEIS being drafted by NMFS. Whatever the outcome of this
27 examination, it is not likely that these effects on bottom habitat would have any negative impact
28 on listed species in the Action Area, or adversely impact critical habitat in any manner that
29 would diminish its value for both the survival and recovery of Steller sea lions.

30
31 The rate of biomass removal inside critical habitat varies considerably by gear types (Table 6.3).
32 Figures 6.11 and 6.12 display the harvest rate by gear type for both the BSAI and GOA (top
33 panel) and the resulting cumulative catch by week (bottom panel) in 1999. The BSAI is
34 characterized by two pulses of fishing, driven largely by the trawl sector. Trawl removals
35 reached 100,000 mt per week in both the spring and fall time periods. The trawl peak is evident
36 in the cumulative catch (bottom panel) marked as the A and B time periods where the slope of
37 the line is greatest. The hook-and-line sector removed about 5,000 mt per week during the first
38 half of the year, and about the same rate in a second season in late September, October, and early
39 November. The hook-and-line sector results in a relatively constant removal rate and a
40 cumulative catch with a more constant slope (Figure 6.11b). The pot and jig sectors compose
41 much less of the catch in the BSAI, the pot sector takes most of its catch in April and May after
42 the crab seasons close. Similar patterns are observed in the GOA, but the B season in the GOA
43 (Figure 6.12b) is much longer than in the BSAI and is composed of a number of spikes starting in
44 July and running through November, with rates of about 10-15,000 mt per week. While the
45 majority of the catch occurs from trawling, pot and hook-and-line gear represent a higher
46 proportion of the catch than in the BSAI.

47
48 In terms of effects on ESA-listed species, the slower and more dispersed nature of the hook and
49 line and pot fisheries make localized depletion less likely than would be possible with trawl gear.

1 In addition, fleet capacity is currently much smaller, although hook and line and pot capacity
2 could grow in the future if circumstances favor use of those gears.
3

4 **6.3.4.4 Time/area catch management** 5

6 Time/area management measures are promulgated for 3 primary reasons: prohibited species
7 bycatch management, habitat protection, and catch dispersion. Examples of prohibited species
8 bycatch management areas include the chum salmon and red king crab savings areas. Habitat
9 protection areas include the Pribilof Islands pelagic trawl closure to protect blue king crab habitat
10 and the trawl exclusion zones around Steller sea lion rookeries and haulouts. Furthermore, ABCs
11 and TACs for many species, including Atka mackerel, many rockfish, pollock, Pacific cod, are
12 allocated among existing management areas to disperse catch throughout the range of the
13 species.
14

15 The management areas used to disperse catch in the Aleutian Islands (areas 541, 542, 543,
16 inside/outside critical habitat for Atka mackerel, rookery and haulout closures) are currently
17 more extensive than those used to disperse catch of pollock in the Bering Sea (Steller Sea Lion
18 Conservation Area, rookery and haulout closures). The limited time/area management applied to
19 the Bering Sea results in a potential for spatial and temporal concentration of catch due, in part,
20 to a mismatch of scales between the area over which resources are surveyed and the area over
21 which catches are removed. The entire eastern Bering Sea shelf is used to estimate total biomass,
22 but few mechanisms exist to distribute the catch over the same area. As a consequence, catch
23 may become concentrated in time and space, with the exception of mandated seasonal
24 distributions of pollock catches. The areas used to disperse catch in the GOA are more detailed
25 but because annual surveys are not performed and there is uncertainty about seasonal
26 movements, interannual or seasonal changes in target stock distributions could result in removal
27 rates that are not proportional to the stock in each area. Furthermore, analysis of the portion of
28 the target stocks within critical habitat have only recently been used in fishery management to
29 estimate the level of biomass inside critical habitat. Also, there are no present control areas for
30 assessing the effects of fishing.
31

32 The spatial patterns of the groundfish fisheries suggest that there is a demand for common
33 resources by fisheries and Steller sea lions. In the BSAI, the portion of each groundfish catch
34 taken in 1999 from critical habitat ranged from 1% for the yellowfin sole fishery to 74% for the
35 sablefish fishery (Fig. 6.13a). By amount, the tonnage removed from critical habitat in each
36 fishery ranged from 657 mt for yellowfin sole and 332,251mt for pollock (Fig. 6.13a). The
37 portion of BSAI pollock, cod, and Atka mackerel catch combined from critical habitat has
38 increased from 12% in 1980 (about the beginning of the joint-venture fishery) to a peak of about
39 66% in 1995, and then dropped to 37% in 1999 (Fig. 6.14a).
40

41 Between 1995 and 1999, about 49% of the total groundfish harvest in the BSAI was taken from
42 critical habitat that has been designated for Steller sea lions (Table 6.3). About 14% of this catch
43 was taken within 20 nm of sea lion rookeries and haulouts in the Bering Sea and 10 nm of
44 rookeries and haulouts in the Aleutian Islands area. The pot sector was the most concentrated in
45 critical habitat (81%) followed by trawl, and then hook-and-line (longline). However, the
46 magnitude of the trawl catch in critical habitat was much greater than pot, about 430,000 mt
47 compared to about 14,000 mt (in 1999). Hook-and-line catch was more dispersed outside of
48 critical habitat on average, and accounts for about 75,000 mt taken outside of critical habitat and
49 about 25,000 mt inside (in 1999). The possible effects of these other gear types were dwarfed by

1 the biomass removed by the trawl sector in 1999, which removed 1,286,852 mt.

2
3 In 1998, the NPFMC implemented management measures to redistribute the Atka mackerel catch
4 inside and outside of critical habitat over a four-year period. In the first year (1999), these
5 measures reduced Atka mackerel catches in critical habitat compared to historic patterns; in
6 2002, the measures should reduce Atka mackerel catches in critical habitat by about 50% from
7 historic levels and would allow 40% of the Atka mackerel catch from inside critical habitat.
8 Management measures implemented in 1999 for the pollock fisheries were intended to reduce the
9 spatial and temporal compression of the fisheries. As a consequence of these measures, the
10 percent catch of all species in critical habitat decreased from about 53% before 1999 to 34% in
11 1999.

12
13 In the GOA, analysis of the historic distribution of catch inside and outside of critical habitat is
14 more complicated than the BSAI. The GOA fisheries are prosecuted by a small boat fleet which
15 has much lower overall observer coverage. The result is that the analysis of fishing effort is
16 skewed by vessels larger than 125 ft (which have a higher observer coverage). Vessels under 60
17 ft are not required to carry observers. Because smaller boats are more likely to fish inside critical
18 habitat, and larger boats are more likely to fish further offshore, the resulting spatial analyses
19 tend to underestimate the catch from critical habitat, this would be important in assessing effects
20 on listed species.

21
22 In 1999, the portion of each groundfish catch taken from GOA critical habitat ranged from 5%
23 for the other rockfish fishery to 81% for the pollock fishery (Fig. 6.13b). By amount, the tonnage
24 removed in each GOA fishery ranged from 89 mt for Atka mackerel to 77,663 mt for pollock
25 (Fig. 6.13b). The portion of the GOA pollock and cod fisheries combined from critical habitat
26 has increased from 19% in 1980 to 65% in 1999 (Fig. 6.14b).

27
28 In the period from 1995-1999, the average catch from critical habitat for all sectors was 54% of
29 the total catch, about 48% of the total catch was within 20 nm of listed rookeries and haulouts.
30 The pot sector was the most concentrated in critical habitat (71%), followed by trawl, and then
31 hook-and-line. However, as in the BSAI, the magnitude of the trawl catch in critical habitat was
32 much greater than pot, about 100,000 mt compared to about 10,000 mt (in 1999). Hook-and-line
33 catch is more dispersed outside of critical habitat on average, and accounts for about 20,000 mt
34 of catch outside of critical habitat and about 7,500 mt inside (in 1999). The possible effects of
35 these other gear types are significantly less than the magnitude of biomass removals by the trawl
36 sector; trawl catch in 1999 was 180,000 mt.

37
38 Management measures were implemented in 1999 to disperse the GOA pollock fisheries spatially
39 and temporally. Before 1999, the catch of all species averaged about 55% in critical habitat; in
40 1999, the catch was about 52% in critical habitat. The reduction was small for several reasons.
41 First, the pollock management measures attempted to increase fishing in the Shelikof Strait
42 conservation area (critical habitat) to distribute the catch in accordance with the distribution of
43 the stock. Second, trawl prohibitions around rookeries and haulouts only extend out to 10 nm.
44 Thus, the critical habitat areas from 10 nm to 20 nm were not protected and the catch actually
45 increased in those areas from 1999.

46
47 Temporal patterns of the groundfish fisheries can have the same effects as spatial concentration:
48 fisheries may become so concentrated in time that prey resources are depleted relative to the
49 needs of other predators in the ecosystem. Because the needs of other predators may change with

1 the seasons, temporal concentration is of greater concern when those needs are perceived to be
2 the greatest. For example, Steller sea lions appear to be most sensitive during the winter when
3 adult, female, sea lions may be pregnant with one fetus and lactating to support a pup. Pups may
4 be making the difficult transition from nutritional dependence on their mother to nutritional
5 independence. Juvenile sea lions that have been weaned and are feeding on their own are
6 vulnerable to changed in food supply because of their smaller size and greater energy
7 requirements.
8

9 The temporal distribution of the BSAI fisheries is determined primarily by the pollock fisheries
10 (Fig. 6.15). In general, the fisheries are concentrated in fall and late winter periods with
11 relatively little fishing in the spring/summer (Fig. 6.15). Daily catch rates inside critical habitat
12 have been reduced by about 50% since 1995, and a portion of the catch has been shifted to areas
13 outside of critical habitat.
14

15 In the GOA, the smaller quotas and relatively large fishing capacity have resulted in a pattern of
16 short, pulsed fishing that has changed little over the past five years, both inside and outside of
17 critical habitat (Fig. 6.15). A number of fisheries with split seasons and bycatch apportionments
18 tend to spread these pulses out over the year. The most seasonal catch occurs in the Pacific cod
19 fishery which is harvested primarily in the winter/spring period around March. The rate of
20 removal for the GOA fisheries varies by year, with maximum rates between 3,000 and 8,000 mt
21 per day. The higher rates are from short pollock openings, on the order of days to just over a
22 week in many cases. The primary change illustrated in Figure 6.15 appears to be that highly
23 pulsed pollock fishing was avoided in 1999. The GOA pollock fishery was split into four
24 seasons beginning in 1999, but the third and fourth seasons were separated by only a matter of
25 days, and effectively constitute one season.
26

27 As with many protected species and fisheries interactions, fishermen are often exploiting the
28 same areas of the ocean and times of year as the protected species—both “predators” are taking
29 advantage of the most productive areas with greatest catchability. Management measures that
30 spread effort in time and space would be expected to reduce impacts.
31

32 **6.3.4.5 Bycatch**

33
34 Catch of non-target species (bycatch) occurs during fishing. NOAA (1998) uses the following
35 terms to describe bycatch.
36

37 **Bycatch** — defined as the discarded catch of any living marine resource plus retained
38 incidental catch and unobserved mortality due to a direct encounter with fishing gear.
39 Information on bycatch, either incidental or of prohibited species, retained or discarded,
40 is difficult to obtain. Sampling rates for bycatch may be lower than for target catch, and
41 because fishermen may have incentives to under-report discarded bycatch, total estimates
42 of bycatch may not be reliable.
43

44 Trawl fisheries account for most of the bycatch of prohibited species caught in both the
45 BSAI and GOA. Bycatch of salmon species in the trawl fisheries could result in the take
46 of ESA listed salmon originating in Washington and Oregon waters, and is a matter of
47 concern to the Council and NMFS. Halibut is a significant bycatch species in the hook-
48 and-line fisheries and often acts to limit the total removals of groundfish due to the
49 attainment of halibut mortality caps. There is a small bycatch of crab in the pot fisheries.

1 Bycatch regulations involve a complex suite of measures to minimize bycatch of
2 incidental species, prohibited species, and protected species. This suite of measures
3 includes gear allocations, seasons, bycatch limits, and discard rules. Some of the rules
4 are fixed in regulation and others are determined annually during the TAC setting
5 process. Bycatch is generally an important consideration in any measures that change
6 the prosecution of a fishery.
7

8 **Discarded catch** — defined as living marine resources discarded whole at sea or
9 elsewhere, including those released alive. In 1999, about 1.3 mmt of groundfish was
10 harvested in the BSAI, of which about 9.6% was discarded. The highest discard rate was
11 in the catcher/processor sector (14.7%). In the GOA, about 227,000 mt of groundfish
12 was harvested, of which about 11% was discarded. Again, the highest discard rate was
13 in the catcher/processor sector (22%). The improved retention/improved utilization
14 (IR/IU) program has reduced discards in the Pacific cod and pollock directed fisheries.
15 The program is intended to expand to the rock sole and yellowfin sole fisheries in the
16 BSAI and shallow-water flatfish in the GOA beginning in 2003.
17

18 **Incidental catch** — catch that is not a part of the targeted catch. This includes retained
19 nontargeted catch and discarded catch. For example, any catch of Pacific cod after it is
20 closed to directed fishing is considered incidental catch. Amounts can be retained up the
21 Maximum Retainable Bycatch (MRB) limit, then further catch must be discarded.
22

23 **Total catch** — retained catch plus discarded catch. As discarded catch is included in the
24 total catch, it is counted against the TAC or quota for target species. Discards are wasted
25 in the sense that they are not utilized by the industry. However, to the extent that they
26 are accurately reported they are still accounted for and are not additional to the TACs. A
27 number of fisheries (e.g., some rockfish fisheries) are closed at the beginning of the year
28 and are prosecuted entirely as a bycatch fisheries. However, management of incidental
29 catch can be imprecise and the TACs have been exceeded for a number of species over
30 the last few years. In the BSAI, for example, the “other red rockfish” assemblage was
31 exceeded by 30% of its TAC in 1998, approaching the overfishing level. Once the
32 overfishing amount is reached, management may be required to close all fisheries with
33 bycatch of these species.
34

35 **Bycatch mortality and unobserved mortality** — all mortality of living marine
36 resources associated with discarded catch plus unobserved mortality. Unobserved
37 mortality is due to a direct encounter with fishing gear that does not result in the capture
38 of that species by a fisherman. This includes mortality due to lost or discarded fishing
39 gear, as well as live releases that subsequently die.
40

41 We are unable to estimate the significance of unobserved mortality. Such mortality is a
42 matter of growing concern among stock assessment scientists as it may be
43 underestimated, may contribute significantly to total fishing mortality, and may influence
44 the status of stocks.
45

46 **Regulatory and discretionary discards** — regulatory discards are those required by
47 regulation. Prohibited species are regulatory discards. Discretionary discards are those
48 that are discarded because of undesirable species, size, sex, or quality, or for other
49 reasons, including economic discards as defined in the Magnuson-Stevens Act.

1 **Prohibited species** — a species for which retention is prohibited in a specific fishery.
2 Prohibited species are non-groundfish species that typically were fully utilized in
3 domestic fisheries prior to the passage of the Magnuson-Stevens Act in 1976. Retention
4 was prohibited in the foreign, joint venture, and domestic groundfish fisheries to
5 eliminate any incentive that groundfish fishermen might otherwise have to target these
6 species. The listed prohibited species include: Alaska king crab, Tanner and snow crab,
7 Pacific halibut, Pacific salmon species and steelhead trout, and Pacific herring.
8

9 Trawl fisheries account for most of the bycatch of prohibited species caught in both the
10 BSAI and GOA. The trawl Pacific cod fishery caught 1,364 mt of halibut in 1999, about
11 34% of all of the halibut bycatch in the BSAI. Halibut is a significant bycatch species in
12 the hook-and-line fisheries and often acts to limit the total removals of groundfish due to
13 the attainment of halibut mortality caps. Bycatch of salmon species in the trawl fisheries
14 could result in the take of ESA listed salmon originating in Washington and Oregon
15 waters, and is of special concern to the Council and NMFS. In 1999, the BSAI trawl
16 fishery for pollock caught an estimated 10,381 chinook salmon and 44,611 “other
17 salmon”, far greater than any of the other directed fisheries. Crab bycatch occurs mostly
18 in the trawl fisheries as well, with relatively high bycatch rates in the Pacific cod pot
19 fishery.
20

21 **Forage Fish** - in the BSAI and GOA, the “forage fish” category refers to the following
22 species assemblage:
23

- 24 1. *Osmeridae* (eulachon, capelin and other smelts);
- 25 2. *Myctophidae* (lanternfishes);
- 26 3. *Bathylagidae* (deep-sea smelts);
- 27 4. *Ammodytidae* (Pacific sand lance);
- 28 5. *Trichodontidae* (Pacific sandfish);
- 29 6. *Pholidae* (gunnels);
- 30 7. *Stichaeidae* (pricklebacks, warbonnets; eelblennys, cockscombs and shannys);
- 31 8. *Gonostomatidae* (bristlemouths, lightfishes; and anglemouths), and
- 32 9. The Order *Euphausiacea* (krill).
33

34 Directed fishing for forage fish is prohibited at all times in the BSAI and GOA
35 (50 CFR 679.20(i)(3)). Aggregate forage fish incidental catch retention limits are 2%
36 against other retained species of groundfish. Reliable biomass estimates for forage fish
37 is not available. Additionally, catch estimates are limited because of a lack of catch
38 accounting in the “blend” database for forage fish species. However, estimates have
39 been obtained from the observer database indicating that incidental catch of forage fish is
40 relatively low.
41

42 **Other Species** — the “other species” category includes sculpins, sharks, skates and
43 octopus. Forage fish, as defined at 50 CFR part 679.2 are not included in the “other
44 species” category. The TAC for “other species” equals 5 percent of the sum of TACs for
45 all target species. A preliminary stock assessment was prepared for 2000 for the other
46 species assemblage, in an effort to present the available information for these species and
47 to explore the possibility of single species ABC determinations in order to ensure
48 protection to the species.
49

1 **Nonspecified Species** — defined as those fish species, other than prohibited species, for
2 which TAC has not been specified (e.g., grenadier, prowfish, lingcod). No reliable
3 estimates for biomass or catch are available, and they are generally caught in small
4 amounts and are not commercially valuable at this time. However, we have no way of
5 determining whether adequate protection in the single species context is being provided
6 for these species.
7

8 **Protected species** — any species that is subject to special conservation and management
9 measures (e.g., Marine Mammal Protection Act, ESA, and Migratory Bird Treaty Act).
10 From 1990-1995, observed minimum mortality of Steller sea lions has been estimated to
11 be 30 animals per year (Hill and DeMaster 1999). As described in the Environmental
12 Baseline, incidental catch of Steller sea lions was a serious problem in the 1960s and
13 1970s, but is no longer a major concern with respect to population level effects.
14

15 Annual bycatch of seabirds in the BSAI has been about 1 short-tailed albatross; 410
16 Laysan albatross; 31 black-footed albatross; 8,064 northern fulmars; 2,074 gulls; and
17 1,036 shearwaters. In the GOA, annual bycatch has been about 0 short-tailed albatross;
18 305 Laysan albatross; 611 black-footed albatross; 1,245 northern fulmars; 124 gulls; and
19 82 shearwaters. In 1997, NMFS required operators of hook-and-line vessels fishing for
20 groundfish in the BSAI and GOA and federally-permitted hook-and-line vessels fishing
21 for groundfish in Alaska waters adjacent to the BSAI and GOA to employ specified
22 seabird avoidance measures (62 FR 23176, April 29, 1997). The purpose of these
23 measures is to reduce seabird bycatch and incidental seabird mortality. These measures
24 were necessary to mitigate hook-and-line fishery interactions with the short-tailed
25 albatross and other seabird species. In 1998, NMFS required seabird avoidance
26 measures to be used by operators of vessels fishing for Pacific halibut in U.S.
27 Convention waters off Alaska (63 FR 11161, March 6, 1998).
28

29 Bycatch is a continuing issue for all of the FMPs in the BSAI and GOA. For the purposes
30 of this consultation, the most significant issue is bycatch of threatened and endangered
31 salmon in the groundfish fisheries. As we discussed in the Environmental Baseline
32 chapter of this opinion, the available information does not allow us to characterize the
33 stock composition of the chinook bycatch in the groundfish fisheries. Consequently, we
34 cannot estimate how the various fisheries in the action area have affected mortality rates
35 of threatened and endangered salmonids over time.
36

37 Despite the limited information on the distribution and abundance of Pacific salmon in
38 the action area and the number that are taken as bycatch in groundfish fisheries, at least
39 small numbers of these salmon can be expected to be caught as bycatch in these
40 fisheries. In particular, we would expect the groundfish fisheries to capture and kill small
41 numbers of Snake River fall chinook, upper Willamette River chinook salmon, Snake
42 river spring/summer chinook salmon, and upper Columbia river spring chinook salmon
43 in the action area. However, an evaluation of the impact of this incidental removal has
44 been addressed in a biological opinion regarding salmon in the Pacific Northwest.
45

46 **6.3.5 Monitoring**

47
48 Monitoring of the fisheries is necessary to ensure that they are prosecuted in compliance with
49 management regulations and do not threaten the health and status of the target stocks or the ecosystem,

1 including listed species and critical habitat. Fishery effects on the target stocks are monitored by two
2 principle methods. First, the catch is monitored by a catch accounting system to ensure that it does not
3 exceed the TAC by excessive amounts. Second, the target stocks are surveyed during a set of research
4 cruises that include annual summer bottom trawl surveys in the BSAI, triennial summer bottom trawl
5 surveys in the GOA and Aleutian Islands (which will become biennial), annual winter hydroacoustic
6 surveys in Shelikof Strait of the GOA, annual summer longline surveys (for sablefish), winter
7 hydroacoustic surveys in the Bogoslof area, and several additional surveys being considered for the near
8 future.

9
10 The objective of the groundfish catch accounting system is to comprehensively account for fishing
11 mortality in the groundfish fisheries. Observers based on catcher-processor and mothership vessels
12 collect data on total catch. Unobserved catcher-processor vessels are required to maintain a daily
13 logbook that details their retained catch and discards. For vessels delivering to shoreside processors the
14 retained, or landed, catch is determined using State of Alaska certified scales at the processor. The at-sea
15 discards of groundfish by the catcher vessels is estimated by expanding discard rates on observed vessels
16 to the fishery as a whole.

17
18 Processor check-in reports provide NMFS with information on the current fishery participants from
19 whom catch reports are expected. NMFS staff monitor the incoming catch reports for completeness.
20 NMFS also regularly compares the information reported to NMFS with the State of Alaska groundfish
21 fish tickets to ensure completeness of the catch accounting database from shoreside processors. NMFS
22 has a high degree of confidence that the catch accounting system succeeds in collecting comprehensive
23 data on groundfish catch.

24
25 Prohibited species catches (PSC) are estimated from averaged observer sampling data, and therefore the
26 PSC estimates are probably better for fisheries with a higher level of coverage. Because observer
27 coverage is based on vessel length, fisheries comprised primarily of vessels under 60' in length lack
28 observer coverage. Examples include the hook-and-line demersal shelf rockfish fishery in the eastern
29 Gulf of Alaska and the BSAI fixed gear Pacific cod fishery for vessels less than 60'. If observer data is
30 available from a similar fishery that has observed vessels, those data are used to estimate PSC for the
31 unobserved fishery.

32
33 Pacific cod is a unique groundfish in that significant amounts of cod bycatch occur in non-groundfish
34 fisheries – specifically the longline Pacific halibut fishery and the pot crab fisheries. The crab fisheries
35 have State observers and some data on Pacific cod bycatch has been collected. The longline Pacific
36 halibut fishery does not have an observer program, so information on Pacific cod bycatch is largely
37 anecdotal. This is not a deficiency in the groundfish fishery catch accounting system as the crab and
38 Pacific halibut fisheries are managed separately. However, mortality of Pacific cod in these non-
39 groundfish fisheries could affect Pacific cod stock assessments, and should be considered in stock
40 assessment. In the 1995 GOA SAFE report, an attempt was made to estimate the Pacific cod bycatch
41 taken in the GOA Pacific halibut fishery (Thompson and Zenger 1995). In that assessment, the 1988-
42 1994 average estimate of bycatch was just over 4,000 t, compared to directed Pacific cod catches in the
43 approximate range of 40,000-80,000 t during the same period (i.e., the bycatch amounted to
44 approximately 5-10% of the directed catch). In the BSAI, where the Pacific halibut catch is much
45 smaller, it is assumed that the bycatch of Pacific cod is also much smaller.

46
47 The observer program is a crucial element of the catch accounting system for the fisheries and has
48 generally been highly successful. However, the program has some deficiencies that confound the
49 monitoring of fishery effects. Observer coverage is based on vessel length, and is required 100% of the

1 time for vessels over 125 ft (see Table 6.4). For vessels between 125 ft and 60 ft, observers are required
2 30% of the time, and the actual time is at the discretion of the vessel operator. Observers are not required
3 for vessels under 60 ft. Because fleet composition varies considerably between the BSAI and GOA
4 groundfish fisheries (the BSAI fleet is comprised of larger vessels), observer coverage is generally better
5 for the BSAI and less complete for the GOA. The lack of information for the GOA fleet has been
6 problematic because the smaller vessels that are not observed are more likely to fish in Steller sea lion
7 critical habitat, but data on those smaller vessels is not available.

8
9 In addition, the length-based requirements for observer coverage shift observations toward larger vessels
10 that participate in single species fisheries with low bycatch rates (e.g., pollock). Less sampling occurs
11 for smaller vessels that participate in fisheries with more diverse catches and higher bycatch. Where
12 bycatch may be higher and observer coverage lower, confidence in discard rate is reduced. When vessels
13 are not observed, their bycatch is estimated on the basis of observed vessels. This approach assumes that
14 vessels without observers behave in a similar manner to vessels with observers. Records from other
15 fisheries have demonstrated that this is not likely to be true, in which case other mechanisms may be
16 required for confidently estimating bycatch.

17
18 With the exception of the above issues, the combination of data from the catch accounting and the stock
19 assessment surveys provides a seemingly comprehensive system for tracking the catch, status, and trends
20 of the BSAI and GOA target stocks. Improvements upon monitoring techniques are constantly being
21 implemented as part of the FMPs. It is highly unlikely that any listed species would be jeopardized as a
22 result of overfishing quotas or groundfish stocks as a result of inadequate monitoring of the fisheries.

23
24 The second significant element of monitoring involves assessment of significant fishery-related effects
25 on the ecosystem, including non-target species, listed species, and critical habitat. The Ecosystem
26 Considerations Chapter of the annual Stock Assessment and Fishery Evaluation Report of the NPFMC
27 summarizes much of the monitoring activities involving other aspects of the ecosystem. Monitoring of
28 climate changes, zooplankton and phytoplankton production, trophic relationships, benthic communities
29 and habitat, and marine mammal and seabirds is summarized there. The document presents indices of
30 changes in the status of some of these components and also attempts to develop ecosystem-based
31 management indicators in an effort to track the efficacy of past management efforts. Again, an expanded
32 discussion of the possible ecosystem effects of fishing is presented in section 6.5.3.

33 34 **6.4 Direct Effects of the FMPs on Listed Species and their Environment**

35 36 **6.4.1 Effects of the global fishery exploitation strategy on listed species**

37
38 By design, fishing significantly reduces the spawning stock biomass from an "unfished" level to a
39 "fished" level. The relevant question is whether fishing under these global (e.g., large scale such as
40 BSAI or GOA wide) exploitation strategies reduces the environmental carrying capacity of listed species
41 by adversely affecting the ecosystem on which they depend for survival.

42 43 **6.4.1.1 Long-term effects of a single-species groundfish exploitation strategy**

44
45 Fishery management actions are intended to allow for the removal of fish biomass in a manner
46 that will result in a long-term, consistent yield to the human population. This strategy supposes
47 that there is "surplus" fish production beyond that required to ensure that, on average, successive
48 generations of a species will replace or surpass themselves. Fisheries models predict that
49 "surplus" production will be maximized at intermediate stock sizes because high stock densities

1 result in more competition for resources which reduces the reproductive rate of the population
2 (Ricker 1975). In a single species context, it is generally considered that this "surplus"
3 production can be safely removed without adversely impacting that stock or the ecosystem; this
4 assumption is analyzed in the following sections.

5
6 The fundamental dynamics of the BSAI and GOA groundfish stocks provide a means for
7 evaluating the long-term effects of fishing over multiple years. The availability of this stock to
8 other consumers in the marine ecosystem (e.g., marine mammals, seabirds, other fish) is
9 determined, in part, by the stock's standing biomass. Figure 6.1b contrasts the theoretical female
10 spawning biomass by age in a fished and an unfished population based on the B40% harvest
11 strategy. This figure suggests that there could be significant reductions in the amount of prey
12 available to other consumers in the ecosystem. In Figure 6.1c, we see that for EBS pollock in
13 1999, that there have in fact been significant reductions especially in the older half of the
14 population (this effect is discussed further in section 6.4.2 below).

15
16 To further demonstrate the reduction in spawning biomass resulting from fisheries in the BSAI
17 and GOA we used recently developed stock assessments that hindcast groundfish population
18 abundance and age structure and compare the fished population with simulations of the stocks
19 without fishing. The biomass of unfished populations was estimated using the estimates of
20 annual recruitment from each stock assessment and subjecting each cohort to natural mortality
21 and somatic growth only. The structure of the fished population was that estimated from the
22 stock assessment process and reflected the effects of the entire fishing history. All other aspects
23 of the two populations, including average weight at age, the proportion of females in the
24 population, the proportion of females mature at age, and natural mortality, were identical in the
25 two data sets. For this analysis, we assumed that the time series of annual recruitment was the
26 same in the unfished and fished scenarios. The results are illustrated in Figure 6.16 for the
27 BSAI stocks and Figure 6.17 for GOA stocks in 1999. Comparisons are made between spawning
28 biomass in the fished and unfished scenarios.

29
30 For example, the female spawning biomass of BSAI pollock in 1999 was 43% of its unfished
31 level (as determined by current fisheries models), cod was 50%, and Atka mackerel was 66%
32 (see Table 6.5). In the GOA in 1999, pollock female spawning biomass was at 61% of its
33 unfished level and cod was 57%. Differences between observed biomasses and those expected in
34 the absence of fishing, indicates that fishing likely have considerably reduced the potential
35 spawning stock biomass of all species. This cumulative effect has occurred over the last 20 years
36 (Figures 6.16 and 6.17). This long-term reduction is reasonably likely to reduce the availability
37 of prey to other components of the ecosystem. Whether the expected unfished biomass would
38 have been fully realized or made available to another predator like Steller sea lions, can not be
39 determined. Additionally, because the time series for the modeling exercise began in 1978, after
40 many years of heavy fishing, we may be underestimating the unfished biomass. However, given
41 these caveats, it does represent our best estimate based upon the best available scientific and
42 commercial data.

43
44 One approach to estimate the cumulative effects of multiple fisheries on prey availability is to
45 sum the difference between the fished and unfished biomasses for all FMP species. For the
46 BSAI in 1999, the combined female spawning biomass for pollock, cod, and Atka mackerel was
47 45% of the expected unfished level. For all species that can be assessed with age-structured
48 models, the female spawning biomass was 54% of the expected unfished level, while total
49 biomass was 58% of the unfished level. For the GOA in 1999, the combination of female

1 spawning biomass and total biomass for pollock and cod was 59% and 46% of the expected
2 unfished level, and 78% for all stocks analyzed with age-structured models (Fig. 6.17). If
3 arrowtooth flounder, neither a major target of the fisheries nor a major prey item for Steller sea
4 lions, is removed from the calculation, then the combined female spawning biomass in the GOA
5 in 1999 was 61% of its expected unfished level.

6
7 These results indicate that the $B_{40\%}$ strategy had not been fully realized for most target stocks at
8 the end of the time series (1999). Stocks may not have been fished at $F_{40\%}$ for a variety of social,
9 economic, or ecological reasons such as prohibited species bycatch, or low market demand.
10 Nevertheless, the differences between observed biomasses expected in the absence of fishing
11 indicate that fishing has considerably reduced the potential spawning stock biomass of each
12 species over the last 20 years. Figure 6.18 illustrates the reduction in eastern Bering Sea pollock
13 biomass by cohort resulting from this exploitation strategy applied over the period from 1982 to
14 1998. This long-term reduction is reasonably likely to reduce significantly the availability of
15 prey to other components of the ecosystem, such as Steller sea lions. In effect, fisheries remove
16 fish from the population before they are “lost” to natural mortality (e.g., other consumers of
17 groundfish).

18
19 These results are based on the same single species models that are used for annual stock
20 assessment. The models do not include compensatory or depensatory mechanisms that,
21 potentially, could mitigate or compound the actual reduction resulting from fishing. Such
22 mechanisms may result from complex interactions that characterize these marine communities
23 and ecosystems, including predator-prey interactions, competition, changes in age structure,
24 density dependence, or other forms of ecological interaction. Efforts to model multi-species
25 interactions are being developed for the purpose of understanding the potential consequences of
26 the existing fishery management approach. For example, one model of the eastern Bering Sea
27 indicates that in the long-term, the predators that benefit most when prey are not removed by
28 fishing are those that consume the youngest prey of a certain species (Jurado-Molina and
29 Livingston 2000). If this is the case and management changes resulted in greater availability of
30 pollock, then predators of small pollock such as fur seals, adult pollock, arrowtooth flounder, and
31 to some extent Steller sea lions, may benefit more than predators that target large pollock. Other
32 modeling exercises indicate that compensation may reduce the actual difference between
33 spawning biomass estimates under fishing and no fishing scenarios (P. Livingston, pers. comm.).
34 While some degree of compensation may be likely, it is also possible that reductions of 40% to
35 60% in the potential spawning biomass of major forage species could have significant
36 consequences for other components of the ecosystem.

37
38 Therefore, multi-species models help identify areas of needed research and identify possible
39 responses of the ecosystem to fishing if predator-prey interactions are the main driving force
40 without much spatial dynamics. However, their predictions are still relatively uncertain for use
41 in management. They can not, for example, be used to reliably describe the response of these
42 marine communities and ecosystems to the reduction of multiple groundfish stocks as predicted
43 by single species models. Despite the uncertainty in the applicability of these models, such
44 exercises provide an important step forward in our attempts to understand ecosystem dynamics
45 and the consequences of management actions. For purposes of this consultation, the directions
46 of biomass change shown by single-species models, remain the best determinant of groundfish
47 stock status for this analysis and determining the effects on listed species. However, having
48 discussed biomass in total terms and based on these single species strategies and models, it is
49 necessary to restate issues raised earlier:

1. Evaluations should be made in an ecosystem context. It is the complex and life stage of prey species available that would affect foraging success.

2. Estimates of food requirements for sea lions (Appendix 3) given current population size are below available biomass even at current fishing mortality, making the case for the hypothesis that temporal and spatial factors (localized depletions) are affecting their ability to forage effectively. Food requirements are discussed in greater detail in section 6.4.3.10

6.4.1.2 Changes in groundfish age distribution

Fishing the same cohorts of a prey stock year after year not only reduces the biomass of the stock, but also changes its age distribution. Over time, a cohort is repeatedly subjected to fishing mortality, thus, older fish become increasingly rare, and the age distribution shifts toward younger cohorts and a younger mean age. Figure 6.1b illustrates this shift for a hypothetical stock with constant recruitment fished under an $F_{40\%}$ exploitation strategy, and Figures 6.1c and 6.4 illustrate this shift for the 1999 EBS pollock stock. For eastern Bering Sea pollock, the mean age of the stock in 1999 would be 3.64 years without fishing compared to 2.65 years with fishing. For eastern Bering Sea pollock, the mean age for fish at least two years old would be 4.69 years without fishing compared to 3.48 years under an $F_{40\%}$ exploitation strategy. Therefore, the “average” individual in the population is more than a year younger, and, more importantly perhaps to a predator, 30% less in mean weight, as far as the effect on Steller sea lions, it would require them to expend more energy foraging for some energy input. Because of the high recruitment variability of pollock, age structure in any given year can be quite unlike the equilibrium pattern, both for fished and unfished populations.

For the Gulf of Alaska the mean age of pollock increased from 3.8 years to 5.5 years from 1991 to 1995 as the strong 1988 year class progressed through the population, then declined to 3.9 years in 1996 with the recruitment of the 1994 year class (Fig. 6.19). Pollock predators have evolved different strategies for coping with this variability, either by consuming a wide spectrum of sizes, by switching to alternate prey, or by conserving energy reserves during times of reduced pollock availability.

This potential for reduction in the average age of fished populations (removal of older fish) could impact listed species by changing the distribution of the fish stock. A reduced average age of fished population may shift the spatial distribution of the stock toward habitats occupied by younger fish. For instance, the geographic distribution eastern Bering Sea pollock varies by age with younger fish found more to the northwestern portion of the eastern Bering Sea shelf. Older, mature fish seasonally move between winter spawning sites in the southeastern Bering Sea and along the outer shelf and summer feeding areas on the middle to outer shelf to the west and northwest. Because the distributions of younger and older fish differ, removal of the older fish will result in a corresponding change in the overall stock distribution (i.e., to one more consistent with the younger fish). This could result in changes in availability of prey to other consumers, particularly those tied to specific geographic features. To our knowledge, the potential consequences of a shift in distribution of fish stocks in the BSAI and GOA have not been analyzed.

6.4.1.3 Changes in reproductive capacity

1 The shift in age distribution described above may affect the reproductive capacity of a fish stock
2 because younger fish are generally less fecund. Beverton and Holt (1957) deduced for fish that
3 the volume of mature ovaries is proportional to the total body volume. For pollock, there is a 9%
4 increase in eggs/kg body weight for age-15 pollock relative to age-4 pollock. Given an $F_{40\%}$
5 harvest rate, where female spawning biomass per recruit was reduced to 40% of the unfished
6 biomass, egg production per recruit was reduced by 61% (Ianelli et al.1999).

7
8 Models which extend spawning biomass per recruit analysis to account for maternal influences
9 indicate a tendency for mature female biomass to underestimate reproductive output by not
10 taking in account the higher quality of reproductive products of older females. Because the
11 abundance of older females is substantially reduced by fishing, harvest policies are potentially
12 more aggressive than intended because mature biomass is used as a proxy for reproductive
13 output. Research into the reproductive biology of pollock and other North Pacific groundfish
14 stocks is needed to assess the importance of maternal influences on reproductive output.

15 16 **6.4.2 Direct effects of fishing on short term/local prey availability**

17
18 Competition has been defined in many ways. Although the various definitions have important
19 differences, each definition has two basic elements (a) competition occurs between two or more
20 individuals (or populations) that actively demand a common resource and, (b) in meeting those demands,
21 reduce a resource's availability to other individuals or populations or that the resource is in short supply
22 relative to the number seeking it. We will evaluate the information available to determine if it allows us
23 to conclude that the fisheries compete with Steller sea lions.

24
25 The data necessary to resolve whether groundfish fisheries of the BSAI and GOA compete with listed
26 species is sparse. First of all, we do not have comprehensive information on the structure and
27 composition of the marine ecosystem before commercial exploitation of fisheries began, nor do we have
28 information on the population cycles of fish, marine mammals, and seabirds over long periods of time
29 that would provide a solid foundation for this type of analysis. Nevertheless, these effects are not merely
30 theoretical; competition between fisheries, marine mammals, and seabirds have been observed
31 worldwide. Based on these studies we believe competition could exist between groundfish fisheries,
32 marine mammals, and seabirds in the BSAI and GOA.

33
34 Competition between the groundfish fisheries and non-human predators in the marine ecosystem of the
35 BSAI and GOA can occur at different spatial and temporal scales. At the macro-scale, potential impacts
36 of fishing include competition for a common resource and/or shifts in predator prey relationships
37 resulting from direct mortality and by shifts in the carrying capacity. These impacts are superimposed on
38 a natural system that is fluctuating due to external forcing at the seasonal, interannual and interdecadal
39 time scales. Differentiating fishery induced shifts in fish distribution from natural shifts due to changes
40 in oceanographic conditions is an active field of research in the marine community. At current harvest
41 levels, the impacts of commercial harvest on the macro-scale distribution of walleye pollock and Pacific
42 cod are not easy to distinguish.

43
44 Competition can also occur on a meso-scale if the fisheries affect the distribution or abundance of
45 groundfish in a region (such as Shelikof Strait or Bristol Bay). Finally competition can occur on a micro-
46 scale if fishing vessels affect the distribution and abundance of groundfish in specific locations. With
47 decreasing spatial scale, there is a corresponding decrease in the temporal dynamics of competition: the
48 effects of fisheries on the distribution and abundance of fish species have shorter duration as spatial
49 scales decreases.

1 **6.4.2.1 Active demand for a common resource**
2

3 Competition between fisheries, marine mammals, and seabirds has a long history and has been
4 described from different perspectives. On one hand, fishermen have observed the numbers of
5 target species that have been consumed by marine mammals and seabirds and treated the
6 mammals and birds as economic competitors for their catch (Furness 1984). For example, in the
7 1980s, the British government considered reducing the grey seal population at colonies around
8 Britain to increase the quantity of commercial fish species (Furness 1984). On the other hand,
9 biologists and conservationists have observed the large amount of biomass that is removed from
10 marine ecosystems by fisheries and have been concerned that the fisheries compete with marine
11 mammal and seabird populations.
12

13 In the Environmental Baseline, it was noted that fishermen historically viewed Steller sea lions
14 and other pinnipeds as nuisances or competitors, partially because they competed with the
15 fishermen for fish (Mathisen et al. 1962). As a result, the federal and state government
16 sanctioned efforts to reduce the size of the sea lion population through bounty programs,
17 controlled hunts, and indiscriminate shooting until the sea lions were protected by the MMPA in
18 1972. The total number of sea lions killed between 1900 and 2000 is unknown, but Alverson
19 (1992) suggested that 34,000 or more Steller sea lions were killed intentionally from 1960 to
20 1990. During this period, fishermen were seen killing adult sea lions at rookeries, haulout sites,
21 and in the water near boats.
22

23 The Environmental Baseline also noted that large numbers of Steller sea lions had been caught
24 incidentally in foreign commercial trawl fisheries in the BSAI and GOA since those fisheries
25 developed in the 1950s (Loughlin and Nelson 1986, Perez and Loughlin 1991). From 1960 to
26 1990, more than 50,000 Steller sea lions were caught in trawl gear or almost 40% of the
27 estimated sea lion mortality during that period (Alverson 1992). Perez and Loughlin (1991)
28 concluded that incidental take contributed to the decline of Steller sea lions by causing the sea
29 lions to decline by 16% in the BSAI and 6% in the GOA.
30

31 Finally, in the Status of Species and Environmental Baseline chapters, we presented data that
32 showed an overlap between Steller sea lion diets and commercial catch of groundfish in the
33 Bering Sea, Aleutian Islands, and Gulf of Alaska (see Fig. 4.5 and Tables 4.4 and 5.2).
34 Combining this dietary overlap with the evidence of direct, local interactions between fishermen
35 and Steller sea lions over almost three decades of fishing suggests that these two consumers -
36 Steller sea lions and fishermen - actively demand a common resource.
37

38 **6.4.2.2 Depletion of resources**
39

40 Marine consumers deplete the biomass of their prey on local scales. Although reductions in
41 biomass at these spatial scales have the shortest duration, they can affect the foraging success of
42 other, individual consumers of the prey species. In 1963, Ashmole suggested that seabirds could
43 deplete the prey base around their nesting colonies, which would reduce the supply of food
44 available to the entire colony and reduce breeding success by limiting food available to
45 fledglings. Ashmole (1963) called this depletion a “halo” around the colony that contained low
46 densities of prey. Furness (1984a) concluded that seabirds can consume almost one-third of the
47 pelagic fish production within 45 kilometers of their nesting colonies, which would place them in
48 competition with commercial fisheries, predatory fish, and marine mammals if they consumed
49 the same sizes of prey. Seabirds in colonies along coastal Oregon can consume as much as 22

1 percent of the fish production around their colonies.

2
3 If seabirds can sufficiently deplete prey resources around their colonies to compete with other
4 members of those colonies it is reasonable to expect commercial fleets, with the kind of fishing
5 power in which an individual net's catch area encompasses 1.5 acres (Springer 1992), would
6 remove more of their target species and any bycatch from the water column and also deplete prey
7 in their fishing grounds.

8
9 Public testimony that several fishermen provided to the NPFMC at its June 2000 meeting
10 provides additional support for concluding that fishing vessels deplete the biomass of groundfish
11 in the action area. While testimony made during a Council meeting is not a substitute for well
12 designed, scientific experiments, the information reported to the Council by fishermen is
13 consistent with the conclusion that highlights the small-scale effects of fishing vessels: the
14 fisheries can cause schooling fish to disaggregate at least over the period of minutes to hours.
15 Fishing causes dense schools of prey species to scatter which affects the foraging behavior of
16 marine mammals and seabirds that target aggregated prey. However, any analysis of this type of
17 effect has to consider how quickly those schools would re-aggregate. Vessel traffic alone may
18 temporarily cause fish to compress into tighter deeper schools or split them into smaller
19 concentrations (Laevastu and Favorite 1988). The passage of one trawl through a school of
20 Pacific whiting was found to create a "hole" in the school due to removal of fish and their
21 avoidance of the gear (Nunnallee 1991). In this study, however, the school structure returned to
22 its pre-disturbance shape and density within tens of minutes after a vessel moved through a
23 school. Repeated trawling by many vessels over several days on fish school structure could
24 make them scatter. Most importantly it could affect Steller sea lion foraging at a local level,
25 although the extent of this effect is not known.

26
27 In previous biological opinions, NMFS indicated that rapid removals of large amounts of fish can
28 reduce their densities. If the density of these fish fell below ecological thresholds for predators,
29 prey, and competing species, we called this phenomenon "localized depletion" but did not define
30 the spatial scale for the term (NMFS 1998, 1999). We will continue to use the term "localized
31 depletion," but only to refer to micro- or meso-scale competition. Previous opinions discounted
32 the possibility of macro-scale competition, but we consider that possibility in this analysis.

33 34 **6.4.2.3 Groundfish depletions at the Action Area or global scale**

35
36 The FMPs for groundfish in the BSAI and GOA have adopted a management strategy that is
37 designed to reduce the spawning biomass of target fish stocks. As a result of this management
38 strategy, the female spawning biomass of pollock in the BSAI in 1999 was 43% of what it would
39 have been if there had been no fishing during the past two decades, or its unfished level as if
40 fishing had not occurred since 1977. Further, cod was 50%, and Atka mackerel was 66%. In the
41 GOA in 1999, the female spawning biomass of pollock was at 61% of this unfished level, and
42 cod at 57%. For the BSAI in 1999, the combined female spawning biomass for pollock, cod, and
43 Atka mackerel was 45% of the expected unfished level. For all species that can be assessed with
44 age-structured models, the female spawning biomass was 54% of the expected unfished level.
45 For the GOA in 1999, the combination of female spawning biomass for pollock and cod was
46 59% of the expected unfished level, and 78% for all stocks analyzed with age-structured models.

47 48 **6.4.2.4 Regional-scale localized depletions of groundfish**

49

1 As discussed in the Environmental Baseline chapter and previous biological opinions (NMFS
2 1998a), the groundfish fisheries in the action area have depleted groundfish in large sections of
3 the action area (to an extent greater than the global depletion described above). One example is
4 the Donut Hole fishery for pollock, which was conducted by trawl vessels from Japan, the ROK,
5 Poland, the People's Republic of China, and the former Soviet Union. From the mid-1980s to
6 1989, annual harvests in the Donut Hole rose to about 1.5 million metric tons from the mid-1980s
7 to 1989. In 1991, the harvest was under 300,000 metric tons and under 11,000 metric tons in
8 1992, before fishing was suspended in the area in 1993 to allow the stock to rebuild. The fishery
9 has not resumed since 1993 as the stocks are still low in abundance. The historical biomass trend
10 for the pollock stock in the Donut Hole fishery, as measured by the spawning biomass in the
11 Bogoslof area, shows a general declining trend as follows: 2.4 mmt (1988), 2.13 mmt (1989),
12 1.29 mmt (1991), 0.94 mmt (1992), 0.64 mmt (1993), 0.94 mmt (1994), 1.1 mmt (1995), 0.68
13 mmt (1996), 0.39 mmt (1997), 0.49 mmt (1998), 0.48 mmt (1999), and 0.30 mmt (2000). In
14 addition, all trial fishing operations since 1997 have encountered little or no pollock in the
15 central Bering Sea.

16
17 As in the above cases, fishing may hasten the decline of stocks that are already declining due to
18 natural reasons. Shelikof Strait pollock is an example of this phenomenon (Fritz et al. 1995,
19 National Research Council 1997). A fishery developed after a large spawning aggregation was
20 discovered in the Strait in the late 1970s. Pollock catches in the Gulf of Alaska increased from
21 less than 100,000 metric tons to more than 300,000 metric tons, although harvest rates remained
22 essentially constant and at what was considered a sustainable level. Because of declining
23 recruitment and fishing removals, the exploitable biomass of pollock in the Gulf of Alaska
24 declined from 3 million tons in 1981 to less than 1 million in 1993 (NPFMC 1993).

25
26 Localized depletions associated with the Atka mackerel fishery based on in-season changes in
27 CPUE of the Atka mackerel fishery were identified at three BSAI locations (Seguam Bank, Petrel
28 Bank, and Kiska Island) and one location in the GOA from 1992 to 1995. During a review of
29 these fisheries, it was recognized that rates of removal exceeded rates of immigration. Comparing
30 biomass estimates between years, it became apparent that temporary reductions in the sizes of
31 local Atka mackerel populations could affect other Atka mackerel predators, such as the Steller
32 sea lions. Subsequent Leslie depletion analyses were completed for 37 time-area fisheries in
33 1986-97. The areas analyzed included east and west of Buldir Island, west of Kiska Island, two
34 areas south of Amchitka Island, north of the Delarof Islands, the east side of Tanaga Pass, and
35 south of Seguam Island. With an alpha value of 0.05, a total of 17 of the 37 time-area fisheries
36 yielded statistically significant relationships between cumulative catch and CPUE. The CPUE
37 increased significantly in one case and declined significantly in 16 cases. In general, the greater
38 the total catch in an area, the more likely CPUE declined significantly.

39
40 These assumptions appeared to be reasonable for the Atka mackerel fish stock in the central and
41 western Aleutian Islands. Mackerel are found in well-defined habitat and the fishery operates at
42 relatively constant locations. The duration of the fishery is relatively short so that natural
43 mortality and migration into and out of the fish stocks are likely limited. Catchability could
44 change over the course of the fishery, but if such changes occur, say as a result of dispersion or
45 altered schooling behavior, those changes could also have detrimental affects on foraging sea
46 lions. Finally, the use of CPUE as direct measure of fish density or abundance has problems, but
47 CPUE is commonly used as a reliable index of density or abundance.

48
49 In this case, the fishery might have resulted in a decreased ability of foraging Steller sea lions to

1 secure enough prey. As a result, in 1999 and 2000, NMFS and the NPFMC made changes to the
2 Atka mackerel fisheries in the BSAI to reduce the potential and intensity of competitive
3 interactions with endangered Steller sea lions. Two fishery exclusion zones were extended from
4 being effective January through April, to the remainder of the year, and the TAC was split into 2
5 seasons. This had the effect of spatially and temporally dispersing the fishery to prevent
6 localized depletion due to pulse fishing. The TAC was also reduced with a phased-in schedule
7 so that the proportion of catch occurring in Steller sea lion critical habitat would be progressively
8 reduced from nearly 80% of the TAC being taken inside critical habitat to 40% in 2002.
9

10 **6.4.2.5 Disturbance to groundfish schooling patterns caused by fishing**

11
12 Sensitivity of listed species to disturbance associated with commercial fishing varies by species,
13 individual, age, sex, season, reproductive state, habitat, and the degree to which they have been
14 sensitized or habituated to disturbance. For example, Calkins and Pitcher (1982) found that
15 disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions.
16 Sea lion reaction to occasional disturbances ranges from no reaction at all to complete and
17 immediate departure from the haulout area. Johnson et al. (1989) evaluated the vulnerability of
18 Steller sea lions on rookeries and haulouts, and also noted a variable response to noise and
19 disturbance. While sea lions have continued to use some areas after repeated disturbance, they
20 have temporarily or permanently abandoned others (Thorsteinson and Lensink 1962, Kenyon
21 1962).
22

23 With respect to Steller sea lions, the issue of disturbance of foraging patterns has been closely
24 related to the issue of temporal concentration of the fisheries. The concentration of fishing effort
25 into short periods of time may increase the likelihood or intensity of disturbance during the
26 fishery, followed by a period of relatively little or no disturbance. On the other hand, fisheries
27 that are broadly distributed over time may cause a low, but prolonged, level of disturbance.
28 Because temporal concentration may have greater significance in terms of creating localized
29 depletions of prey, new management measures have emphasized the need to disperse the fisheries
30 over time.
31

32 The potential for disturbance or interference competition may be more significant when prey
33 resources are concentrated in a small area over a short period of time. Salmon and herring
34 fisheries, for example, tend to occur in pulses to take advantage of the brief availability of prey
35 concentrations. Other predators, including Steller sea lions, may be excluded from foraging
36 opportunities by concentrated fishing activity. This issue will be considered again in the chapter
37 on Cumulative Effects.
38

39 Current fishery (and sea lion) management measures do not assume that disturbance effects from
40 fishing on foraging efficiency of Steller sea lions are negligible. The rationale behind
41 establishment of trawl exclusion zones around rookeries in 1991-93, and pollock trawl exclusion
42 zones around haulouts in 1999- 2000, was in part, based on reducing disturbance near important
43 terrestrial habitats. Similarly, dispersal of catch and effort in space and time was intended to
44 both decrease the likelihood of localized depletion and reduce the local intensity of fishing (and
45 its disturbance). The level of potential competition, and the effects of vessels in, and around,
46 foraging sea lions, seems to be variable.
47

48 **6.4.2.6 Niche overlap between fisheries and listed species**

49

1 For the purposes of choosing a suitable marine mammal/fishery case for determining whether
2 niche overlap is significant, we applied the qualitative criteria developed by Lowry et al. (1982).
3 To determine the likelihood and relative severity of indirect effects of fisheries on marine
4 mammals, Lowry established criteria based on each marine mammal's diet (with respect to
5 species consumed, size, and composition of prey), feeding strategy, and the importance of the
6 BSAI as a foraging area. This approach is applicable for adjacent waters such as the GOA
7 because many of the same marine mammals found in the BSAI are found in the GOA as well and
8 their diets are comparable.
9

10 Only one of the ESA-listed marine mammal species consumes groundfish species as a large part
11 of their diet and does so in areas coincident with Alaska groundfish fisheries; the Steller sea lion.
12 The remaining species were either distributed across areas not regularly used by groundfish
13 fisheries, or they more often use different prey resources.
14

15 An extensive body of analytical work on the potential competitive interactions of Steller sea
16 lions with pollock or Atka mackerel fisheries has been assembled in recent years (e.g., Loughlin
17 and Merrick 1989; Ferrero and Fritz 1994; Fritz et al. (1995); and Fritz and Ferrero 1998). These
18 fisheries were the obvious starting place for analyses of interactions because their target species
19 are the most prevalent items in the diet of Steller sea lions in the GOA and the BSAI,
20 respectively (NMFS 1998). However, there are many other species targeted by the Alaska
21 groundfish fisheries in the BSAI and the GOA that are also eaten by Steller sea lions. The
22 question of how much overlap actually occurs, however, is highly relevant to determining the
23 effects of these fisheries and the FMP process on Steller sea lions. Therefore, we examined the
24 extent to which Steller sea lions rely more on some of these species than others. Further, are
25 those important prey items consumed coincident with the location, timing or pattern of fisheries
26 removals.
27

28 The following represents the process used to determine which fisheries may be adversely
29 affecting Steller sea lions and whether or not those affects are likely to jeopardize their continued
30 existence or adversely modify their critical habitat. Seven questions were posed for each FMP
31 managed fish species in the fishery management areas. If question 1 was answered "No," then
32 the answers to questions 2-7 were also "No," so the concern level was nil, thus scoring a "0"
33 total. Steller sea lions did not eat the targeted fish species and no grounds for a competitive
34 interaction existed. If question 1 was "Yes", it was scored 1 point; remaining questions 2-6
35 scored 1 point for a "Yes" and zero points for a "No". If question 7 was yes, it scored 2 points to
36 underscore concern for potential effects of localized depletion.
37

- 38 1. Do Steller sea lions forage on the target fish species?
- 39 2. Do Steller sea lions forage on the target fish species at a rate of at least 10% occurrence?
- 40 3. If yes to Number 2, does the size of Steller sea lion prey overlap with the size caught by
41 commercial fisheries?
- 42 4. If yes to Number 2, does the fishery overlap spatially with the area used by Steller sea
43 lions to forage on this species?
- 44 45 4. If yes to Number 2, does the fishery overlap spatially with the area used by Steller sea
46 lions to forage on this species?
- 47 48 5. If yes to Number 2, Does the fishery operate at the same time Steller sea lions are
49 foraging on the fish species?

- 1
2 6. If yes to Number 2, Does the fishery operate at the same depth range that Steller sea lions
3 are using to forage on the fish species?
4
5 7. If yes to 1-6, does that fishery operate in a spatially or temporally compressed manner in
6 Steller sea lion critical habitat?
7

8 Steller sea lion food habits data in NMFS (1998, 1999) and NMFS data(unpublished data -
9 results of food habits analyses based on Steller sea lion scat collections) were used for this
10 analysis along with the fishery distribution information in Fritz *et al.* 1998, to answer the above
11 questions. Table 4.5 provides a summary of the scat collections data which typify the overall
12 results.
13

14 Results of the rating test (Table 6.6) indicated that nine fishery/Steller sea lion combinations
15 suggested no interactions (i.e., scored "0"), 23 scored "1" or "2" and 5 scored "8", the highest
16 possible point total. Those fisheries with the high scores were pollock (BSAI and GOA, Pacific
17 cod (BSAI and GOA) and Atka Mackerel (AI). We considered those with only scant overlap
18 with the fisheries as indicated by scores of 2 or less to have only limited effects on Steller sea
19 lion forage availability and, as such, do not contribute to jeopardy or adverse modification.
20

21 Although the prey item occurrence summary in Table 4.5 was only one of the elements used to
22 determine the degree of competitive overlap between fisheries and Steller sea lions, commentary
23 on the relevance of species with greater than 10% occurrence but low overall scores is warranted.
24 For instance, arrowtooth flounder was found in 22.2% of samples collected in the GOA but it is
25 not flagged as a management concern. This is because this species is not a fisheries target,
26 instead caught as bycatch. Further, the bycatch of arrowtooth is expected to be reduced anyway
27 as a function of measures that reduce the harvest of Pacific cod, one of the principle sources of
28 that bycatch.
29

30 In summary, based on best available scientific and commercial data, the fisheries as authorized
31 under the FMPs compete with Steller sea lions for common resources. Fisheries and Steller sea
32 lions both consume pollock, Atka mackerel, and Pacific cod. The high degree of overlap
33 between these fisheries and the foraging needs of Steller sea lions points to competitive
34 interactions on a number of scales or axes. However, the potential for competition at the local
35 scale could be much larger than any of the global effects given the available biomass and large
36 TACs in these regions and the very small areas that we have observed these TACs to be taken.
37

38 **6.4.3 Effects of global, regional, and local groundfish exploitation: Steller sea lion case study**

39

40 Our information leads us to believe that fisheries do not compete with other listed species, but may with
41 Steller sea lions. Therefore, an examination of specific interactions between sea lions and the fisheries is
42 warranted.
43

44 The scope of this opinion was designed to be comprehensive. Previous biological opinions focused on
45 individual fisheries within the FMPs rather than the whole. Conservation measures and reasonable and
46 prudent alternatives were considered adequate in that context, but in light of this comprehensive analysis
47 on continued fishing authorized by the FMPs and the FMP process considered in this biological opinion,
48 those measures are no longer considered adequate to avoid jeopardizing endangered Steller sea lions and
49 adversely modifying their designated critical habitat.

1 With respect to competition or niche overlap, the existing conservation measures for listed species (as
2 required by previous biological opinions and the RFRPAs) represent a compilation of efforts intended to
3 partition fisheries from removing prey from Steller sea lion critical habitat, and to disperse fisheries in
4 space and time to reduce their effect on prey availability for foraging Steller sea lions. While these
5 strategies are scientifically sound and defensible, and the analysis in this opinion supports the concept
6 that localized depletion (spatial and temporal factors) may be at the heart of the problem, the application
7 of those measures has not resulted in an improvement in Steller sea lion population response. Even
8 though changes in the population trajectory would not be seen for a decade or more, monitoring of
9 rookeries should have given some indication of improvements, such as increases in pup counts.

10 **6.4.3.1 Specific fisheries which compete with Steller sea lions**

11
12
13 Previous biological opinions did not adequately address the effects of fisheries other than those
14 targeting pollock and Atka mackerel. While Steller sea lion diet is dominated by these two
15 species for much of the year, they also consume many other species that are harvested
16 commercially. The current injunction on fisheries inside critical habitat implicates all trawl
17 fisheries, independent of an analysis of their interactions with Steller sea lions (Greenpeace v.
18 NMFS, 106 F. Supp. 2d. 1066) In addition, gear types other than trawl fisheries have also been
19 concluded in this consultation as they are removing groundfish biomass in certain times and
20 areas where Steller sea lions co- occur. Consequently, the scope of this biological opinion and
21 the resulting effects analysis is much broader, and identified the pollock, Atka mackerel and
22 Pacific cod fisheries as competitors with Steller sea lions.

23 **6.4.3.2 Radius of current closure areas around rookeries and haulouts**

24
25
26 In 1999, the RFRPAs established pollock trawl exclusion zones for the GOA at 10 nm while
27 those in the eastern Bering Sea were set at 20 nm. The use of different size buffer zones for the
28 two areas was based on the idea that smaller zones (10 nm) were adequate to encompass the
29 adjacent shelf habitat considered to be especially important to Steller sea lions in the GOA.

30
31 The efficacy of this approach was analyzed by examining the extent of shallow (<200 m) vs.
32 deep water adjacent to each haulout or rookery identified in the RFRPAs using GIS analysis
33 techniques (NMFS unpubl. report1999). The results indicate that the 20 nm boundaries for the
34 EBS protected most of the shelf waters adjacent to rookeries and haulouts, but that 10 nm areas
35 in the GOA (or in the Aleutian Islands) did not satisfy the original intent of the earlier biological
36 opinion to create no trawling zones that encompassed important shelf waters adjacent to
37 rookeries and haulouts. Rather, the 10 nm pollock trawl exclusion zones allowed for substantial
38 fishing in Steller sea lion critical habitat from 10 to 20 nm where disruptions of the prey field and
39 reduced biomass could affect critical foraging of Steller sea lions in vulnerable life stages. Based
40 on this new information, descriptions of foraging behavior and what little satellite data is
41 available on Steller sea lions as presented in section 4, and the broader consideration of all the
42 groundfish FMPs and the FMP process that is the scope of this biological opinion, the radius of
43 exclusion zones should be expanded to 20 nm to encompass all critical habitat around their
44 rookeries and major haulouts. A precautionary strategy to protect substantial portions of critical
45 habitat is warranted, with less restrictive measures in more expansive and less used habitats in
46 the greater parts of the Bering Sea and Gulf of Alaska.

47 **6.4.3.3 Extent of closure areas across critical habitat**

48
49

1 Based on the foraging distribution of Steller sea lions (see section 4.8), NMFS designated critical
2 habitat for the species on August 27, 1993 (58 FR 45269). NMFS used both observations and
3 incidental take of Steller sea lions to determine the appropriate area to list as critical habitat
4 under the ESA. The critical habitat boundary was not intended to include the entire geographic
5 area used by foraging Steller sea lions. As required by the ESA, critical habitat must include
6 only those areas necessary for the conservation of the species. When designating critical habitat
7 in 1993, NMFS acknowledged that other aquatic habitats within their range are essential to
8 Steller sea lions for foraging. Three relatively large foraging areas were also listed as critical
9 habitat in addition to the 20 nm boundaries around listed rookeries and haulouts (i.e., Seguam
10 Pass, the Bogoslof Foraging Area in the southeastern Bering Sea, and Shelikof Strait Foraging
11 Area).

12
13 Previous opinions focused on protection of immediate critical habitat around rookeries and
14 haulouts, and placed less emphasis on the outer margins of the 20 nm foraging zones around
15 rookeries or foraging areas. Our understanding of Steller sea lion foraging distribution is based
16 on sightings at sea or observations of foraging behavior (or presumed foraging behavior) in areas
17 such as the southeastern Bering Sea, NMFS unpublished data from the Platform-of-Opportunity
18 Program [POP]), records of incidental take in fisheries, and satellite-linked telemetry studies.

19
20 The results of the telemetry studies suggest that foraging distributions vary by individual, size or
21 age, season, site, and reproductive status. Those reports have served as the basis for much of our
22 understanding of Steller sea lion foraging ecology. The early deployments emphasized adult
23 females with pups during the breeding season simply because at the time those animals were
24 most accessible and their status and foraging ecology were of prime interest. Research has
25 focused on animals less than 4 years old during fall through early spring for both NMFS and
26 ADFG deployments. For adult females, the current information suggests that they remain within
27 20 nm during the breeding season, as well as other seasons if they are nursing a pup. Once the
28 breeding season ends (late July/early August) this general pattern may change. The current
29 tagging data suggests that adult females without pups can forage extensively outside of critical
30 habitat. Although the data are severely limited 55 percent of satellite positions “hits” at sea for
31 this age group from October through December occur outside of critical habitat. Since most of
32 the animals instrumented have been either females or pups, the data may not accurately represent
33 the male portion of the population, which we also believe are much more likely to disperse over
34 larger areas. Finally, the telemetry data available is difficult to interpret regarding the
35 importance of foraging areas outside of critical habitat, because animals must swim a minimum
36 of 20 nm to get out of critical habitat and 20 nm back through critical habitat to get to their
37 destination. In contrast to waters considered critical habitat, the Bering Sea and Gulf of Alaska
38 are large bodies of water allowing for wide dispersal of animals and fish. Consequently, it may
39 be less likely that individual animals and individual fishermen would be concentrated in any one
40 area at any one time.

41
42 Based on this entire suite of information, substantial individual variation in distance traveled
43 occurs for foraging Steller sea lions. Overall, the available data suggest two types of foraging
44 patterns: 1) foraging around rookeries and haulouts that is crucial for adult females with pups,
45 pups, and juveniles, and 2) less concentrated foraging that may occur over much larger areas
46 where these and other animals may range to find the optimal foraging conditions once they are no
47 longer tied to rookeries and haulouts for reproductive or survival purposes. Sea lions disperse
48 widely to forage throughout much of the BSAI and the GOA. Such broad dispersal may be
49 essential to sea lion populations to take advantage of distant food resources and, as a

1 consequence, limit intra-specific competition near rookeries and haulouts. The pattern of
2 foraging (as determined from observations) seems to follow the continental shelf break (i.e. the
3 200 m isobath) suggesting the type of foraging locations preferred as opposed to the need to
4 travel specific distances from rookeries or haulouts. This makes logical sense because the
5 oceanographic conditions along continental shelf breaks tend to be highly productive
6 environments. This continental shelf break foraging areas is consistent with the designated
7 critical habitat zones in the GOA, but extend well beyond critical habitat and designated foraging
8 areas in the BSAI. For that reason, it is necessary to protect significant portions of critical
9 habitat around rookeries and haulouts, and designated foraging areas, in the GOA in a similar
10 manner to those in the BSAI.

11 **6.4.3.4 Temporal dispersion of fishing effort**

12
13
14 Currently a patchwork of measures are in place for temporal dispersion of pollock and Atka
15 mackerel fisheries, and none (except those which seasonally allocate halibut bycatch) are in
16 place for Pacific cod fisheries. For pollock in the EBS, there are 4 seasonal harvest limits for
17 pollock inside the Sea lion Conservation Area (SCA). Seasonal harvest limits within the SCA
18 are not required to be taken in the SCA, they are simply limits so that any of the allowance could
19 be taken outside. Outside the SCA, there were only 2 seasons, one which spans the A and B
20 seasons inside the SCA, and the other which spans the C and D seasons. Because the fishery
21 could shift catch from SCA to the area outside of the SCA, in 1999 and 2000 the fishery caught
22 the entire B season SCA allowance (scheduled for release on April 1) outside (available January
23 20). The roe season results in an economic incentive for fishermen to forego taking fish in
24 critical habitat in favor of fishing outside, which would be a positive effect as long as fishing
25 didn't concentrate right on the edge of critical habitat, forming an impermeable barrier to fish.
26 This resulted in an A-season fishery in 1999 and 2000 that had only marginally more temporal
27 dispersion than in 1998 (Figure 6.15a). In 1999, there was proportionally more pollock caught in
28 late-February and early March than in 1998, but little or no catch beyond mid-March. For
29 pollock in the GOA, the season start dates are January 20, March 15, August 20, and October 1,
30 with 30%, 15%, 30%, and 25% of the pollock TAC assigned to each season, respectively. For
31 Atka mackerel fisheries, the new current management measures implement two seasons.
32 Currently, there are no seasons for Pacific cod fisheries.

33 **6.4.3.5 Consideration of effects at multiple scales**

34
35
36 Previous biological opinions and the RFRPAs have considered the impacts of fisheries on only
37 the regional level, or the scale represented by the management area. The RFRPAs for the
38 pollock fishery and the changes made to the Atka mackerel fishery apportion TAC to large
39 management areas (such as 3-digit statistical areas or the SCA) based on the best available
40 estimates of seasonal biomass distribution. However, fishery impacts at smaller scales, such as
41 those of individual foraging sea lions, were not considered in previous opinions to the extent that
42 they we are in this biological opinion. Consideration of the impacts of fisheries at more than one
43 scale (including the FMP scale) is a new feature of this biological opinion.

44 **6.4.3.6 Seasonal vs. year round closures**

45
46
47 In previous biological opinions, NMFS closed waters around many of the rookeries and haulouts
48 only on a seasonal basis. NMFS has recognized that the sensitivity of sea lions to competition
49 from fisheries may be exaggerated during certain times of the year. Reproduction likely places a

1 considerable physiological or metabolic burden on adult females throughout their annual cycle.
2 Following birth of a pup, the female must acquire sufficient nutrients and energy to support both
3 herself and her pup. The added demand may persist until the next reproductive season, or longer,
4 and is exaggerated by the rigors and requirements of winter conditions. The metabolic
5 requirements of a female that has given birth and then become pregnant again are increased
6 further to the extent that lactation and pregnancy overlap and the female must support her young-
7 of-the-year, the developing fetus, and herself. And again, she must do so through the winter
8 season when metabolic requirements are likely to be exaggerated by harsh environmental
9 conditions. Results from research support, and our previous management actions recognize, that
10 the winter period is a time of great metabolic demands and prey requirements. However,
11 changes in behavior, foraging patterns, distribution, and metabolic/physiologic requirements
12 during the Steller sea lion annual cycle are all pertinent to consideration of the potential impact
13 of prey removal by commercial fisheries. Steller sea lions, at least adult females and immature
14 animals, are not like some marine mammals that store large amounts of fat to allow periods of
15 fasting. Rather, they need more or less continuous access to food resources throughout the year.
16

17 This transition of pups from their mothers to nutritional independence is likely confounded by a
18 number of seasonal factors. Weaned pups are independent of their mothers, but may not have
19 developed adequate foraging skills. They must learn those skills, and their ability to do so
20 determines, at least in part, whether they will survive to reproductive maturity. Seasonal changes
21 may severely confound foraging conditions and requirements, and may be accompanied by
22 changing prey concentrations and distributions, and activities of the fisheries around foraging
23 areas. Spring is also important as pregnant females will be attempting to maximize their physical
24 condition to increase the likelihood of a large, healthy pup (which may be an important
25 determinant of the subsequent growth and survival of that pup). Similarly, those females that
26 have been nursing a pup for the previous year and are about to give birth may wean the first pup
27 completely, leaving that pup to survive solely on the basis of its own foraging skills. Thus, food
28 availability is surely crucial year-round. For that reason, there is a recognized need to protect
29 foraging areas for sea lions on an annual basis, rather than seasonal as recommended in previous
30 biological opinions.
31

32 **6.4.3.7 Distribution of catch outside closed areas in the EBS**

33
34 Critical habitat was in part defined as those waters within 20 nm of rookeries and haulouts, and
35 some more distant areas, that contained features, principally fish, that were “critical” to the
36 survival and recovery of Steller sea lions. However, the extent of critical habitat is not, and by
37 law cannot, be the entire geographic area over which the species ranges (see discussion above).
38 There is a large body of evidence, principally from the Platform of Opportunity database, that
39 Steller sea lions forage well beyond the bounds of critical habitat. In the EBS, there are
40 numerous recent (1990s) sightings of Steller sea lions on the expansive outer continental shelf to
41 the north and west of the SCA, Based solely on fish distribution, it could be expected that Steller
42 sea lions would forage throughout this area. In the summer, approximately half of the pollock
43 and Pacific cod adult biomass is located west of 170W, and a considerable proportion of juvenile
44 biomass of both species is located there as well. However, implementation of the AFA, thanks to
45 fishermen cooperatives, has resulted in a much more evenly distributed fishery along the entire
46 continental shelf edge in the Bering Sea.
47

48 *Effects of the AFA on temporal and spatial dispersion*
49

1 Pre-AFA. In the years up to and including 1998, the BSAI pollock fishery was characterized by
2 an open access race for fish within the inshore and offshore sectors of the fishery. The seasons
3 were of limited length as vessels raced to catch their quota. The pollock roe fishery on the
4 Eastern Bering Sea shelf had been concentrated primarily north and west of Unimak Island.
5 There also had been A season effort along the 200 m contour between Unimak Island and the
6 Pribilof Islands (through 1999). This concentrated catch associated with productive areas
7 surrounding oceanographic features such as the 200 m curve may have resulted in localized
8 depletions of pollock (Appendix 4). This is particularly true in the area just north of Unimak
9 Island in late-January through mid-February and to a lesser extent in the area surrounding the 200
10 m curve southeast of the Pribilof Islands (near Pribilof Canyon) in early February and again in
11 early March.

12
13 Post-AFA In the 2000 pollock fishery, approximately 98 percent of the pollock TAC was
14 allocated to cooperatives (or CDQ groups), and RPAs were in place to disperse effort temporally
15 and spatially, in order to protect Steller sea lions. The 2000 Steller sea lion protection measures
16 were somewhat modified from 1999. The fishery inside the SCA was divided into four seasons.
17 The first two seasons, the A and B season began on January 20 and April 15, respectively. Two
18 non-roe seasons, the C and D season began on June 10 and August 20, respectively. The fishery
19 outside the SCA was divided into just two seasons the A/B season roe fishery and the C/D season
20 non-roe fishery. Catch rates decreased as each cooperative harvested its individual allocation
21 making inseason closure notices unnecessary in fisheries other than the small remaining open
22 access inshore fishery which accounted for approximately 2.5% of the TAC.

23
24 Appendix 4 illustrates minimal concentrations of catch in the horseshoe area north of Unalaska
25 Island and in the area northwest of Unimak Island during the 2000 A/B season. However, in
26 general, effort appears to be dispersed throughout critical habitat and the areas to the northeast.
27 Examination of the fishery in 10-day fishing periods indicate similar dispersed patterns of fishing
28 with no concentrated effort in any of the 10-day periods. No consistent pattern emerges
29 throughout the season; the fishery appears to be prosecuted in several areas in each of the
30 periods. Animated maps showing fishing patterns in 10-day periods are displayed on the NMFS
31 AFSC web site: www.refm.noaa.gov/stocks/cpue/ebharvests.html.

32
33 The incentives to disperse fishing effort for BSAI pollock under the AFA, along with other
34 measures like seasonal allocations of TAC, are expected to continue to disperse fishing in the
35 future.

36 37 **6.4.3.8 Aleutian Islands closure**

38
39 As part of the RFRPAs, NMFS closed the Aleutian Islands area to all directed fishing for
40 pollock. This aspect of the RFRPAs was adopted by NMFS after it had been initially proposed
41 by the NPFMC. While the merits of such a regulation were not described in any detail in the
42 description of the RFRPAs, the NPFMC had intended that the closure of the Aleutian Islands for
43 pollock fishing be used as part of an experiment to assess the efficacy of the RFRPAs. However,
44 as noted earlier in this biological opinion, a majority of the fishing effort in the Aleutian Islands
45 region is directed at species other than pollock, and in particular is directed at Atka mackerel and
46 Pacific cod. Both of these latter two species are important prey items in the diet of Steller sea
47 lions that forage in the vicinity of the Aleutian Islands. Therefore, NMFS has concluded that a
48 closure of the Aleutian Islands region to only pollock fishing is an inappropriate method for
49 conducting research on the question of whether the RFRPAs are effective. Finally, there are no

1 data to suggest that the Aleutian Islands region represents a unique segment of the sea lion
2 population in western Alaska or a segment of the population that, if protected, would improve the
3 prospects of recovery for sea lions in Alaska.
4

5 **6.4.3.9 Ongoing assessment of management efficacy**

6
7 Steller sea lion protection measures implemented to date do not provide mechanisms to facilitate
8 assessment of their efficacy. In essence, evaluation of success was based solely on observation
9 of long term trends in Steller sea lion population. While providing measures adequate to avoid
10 jeopardy and adverse modification, NMFS has agreed to develop a monitoring project that allows
11 evaluation of the management measures and the identification of population response triggers
12 that would facilitate future actions.
13

14 **6.4.3.10 Analysis of Steller sea lion prey requirements**

15
16 There is considerable uncertainty in trying to predict the spatial and temporal distribution of prey
17 species of Steller sea lions in the GOA and the BSAI. Assessment surveys in the BSAI or GOA
18 areas for commercially valuable groundfish are typically done annually or tri-annually. Almost
19 exclusively, these surveys have been conducted in the summer months. Data from these surveys
20 form the basis of the stock assessments reported in the annual SAFE reports. Unfortunately,
21 survey-based estimates of prey abundance on a time and spatial scale adequate to predict the
22 availability of forage to Steller sea lions (e.g., monthly) are not available. Nonetheless, it is
23 possible using the available survey data, commercial catch data, and life history data to estimate
24 biomass in Steller sea lion critical habitat on a monthly basis for three important prey species of
25 the western stock of Steller sea lions (i.e., pollock, Atka mackerel, and Pacific cod) (see NMFS
26 2000; Appendix 3).
27

28 First of all, the ESA requires NMFS to insure that any action it authorizes does not jeopardize
29 listed species or adversely modify their critical habitat. Although this analysis provides a
30 reasonable answer to the question of the amount of forage necessary for Steller sea lions, it does
31 not address the issue of adverse modification of critical habitat. The analysis searches for a ratio
32 between total biomass and the amount consumed by sea lions so that any ratio above a certain
33 threshold would indicate adequate forage is available – in effect it would draw a jeopardy line
34 based on the relative availability of prey. Thus, given the ratios determined in the analysis, the
35 “surplus” is high enough to allow unrestricted fishing up to the TAC in all seasons. However,
36 using the most precautionary data, the results indicate a potential shortage of prey during at least
37 one month of the year and it doesn’t deal specifically with the question of localized availability
38 of prey raised in earlier discussions. Consequently, even though a surplus is available, adverse
39 modification may still be possible unless other measures are used to spatially or temporally
40 disperse the fisheries. This approach would be strengthened with the addition of the following
41 types of groundfish biomass information using surveys:
42

- 43 • Seasonal “global” groundfish biomass estimates using surveys,
- 44 • Spatial groundfish biomass estimates on the scale of critical habitat, and
- 45 • “Local” groundfish biomass estimates to determine the biomass available to
46 Steller sea lions on a scale important to the species (i.e. around a particular
47 rookeries, haulouts, or assemblages).
48
49

1
2 This approach also suffers from limited data on the foraging requirements of Steller sea lions.
3 Two different foraging rates based on published results were presented in the analysis. However,
4 given the uncertainty that this method can insure with the current state of knowledge that the
5 proposed action will avoid adverse modification of critical habitat, other changes to the current
6 management regime would be necessary to be precautionary for Steller sea lions and avoid
7 adverse modification of critical habitat.
8

9 **6.4.3.11 The California sea lion: a case study**

10
11 Insight into interactions between Steller sea lions and the Alaskan groundfish fisheries might be
12 gained by analysis of similar pinniped species in different systems. California sea lions are
13 closely related to Steller sea lions; both are in the family Otariidae, both inhabit the North
14 Pacific ocean, and both reside in areas that have extensive groundfish fisheries. While Steller
15 sea lions have declined 80-90% in the last 30 years, California sea lions have been increasing at
16 over 8% per year since 1983 (Baraff 1999). Furthermore, since the mid-1980s, many groundfish
17 species along the US west coast (California, Oregon, and Washington) have declined
18 dramatically, causing severe fishery restrictions for many rockfish and flatfish species. The one
19 west coast groundfish fishery that has remained relatively robust through the 1990s is that for
20 Pacific whiting (also known as hake). Hake is also a gadid, like walleye pollock and Pacific cod,
21 and is an important element of the diet of California sea lions. Baraff and Loughlin (1999) and
22 Baraff (1999) recently reviewed the potential for interaction between California sea lions and the
23 hake fishery along the west coast. Their findings are briefly reviewed here and compared with
24 the Steller sea lion-Alaskan groundfish fishery case that is the subject of this biological opinion.
25

26 While it is clear the California sea lions eat Pacific whiting, there are distributional differences in
27 the patterns of the fishery and of sea lion foraging on whiting that reduce the potential for
28 competitive overlap (Baraff and Loughlin 1999; Baraff 1999). The most important distributional
29 difference may be that the fishery, which has been prohibited south of 39°N since 1977, does not
30 overlap at all with the entire range of female California sea lions, their pups, and most juveniles.
31 This is also the area of highest estimated sea lion consumption of whiting by California sea lions,
32 primarily juvenile whiting ages 1-3. The only potential for competitive overlap between the
33 fishery and California sea lions is with the southward migration of males in April-June prior to
34 the breeding season. During the remainder of the year, and for the portions of the population that
35 would be most sensitive to prey availability (females and juveniles), there is little or no
36 competitive overlap between the whiting fishery and California sea lions.
37

38 These patterns of whiting fishery distribution off the US west coast and California sea lion
39 foraging on whiting contrast sharply with those observed for the pollock, Pacific cod and Atka
40 mackerel fisheries off Alaska and Steller sea lion foraging on these species. The distribution of
41 these Alaskan groundfish fisheries overlaps considerably with the range of the entire population
42 of Steller sea lions, but particularly the foraging ranges of females and juveniles. Furthermore,
43 the sizes and ages of fish targeted by both fisheries and Steller sea lions are similar. These two
44 case studies show that the potential for competitive overlap between groundfish fisheries and
45 pinnipeds must be examined carefully and individually.
46

47 **6.5 Indirect Effects of the FMPs on Listed Species and their Environment**

48
49 As we discussed in the Environmental Baseline chapter of this opinion, commercial fisheries can have

1 numerous indirect effects that include social effects, economic effects, physical effects, chemical effects,
2 and biotic effects. Other indirect effects of commercial fisheries include the industrial infrastructure that
3 processes the catch and delivers the catch to markets. Fisheries can also have indirect biological effects
4 that occur when fisheries remove large numbers of target species and non-target species (bycatch) from a
5 marine ecosystem. These removals can change the composition of the fish community with associated
6 effects on the distribution and abundance of prey organisms (Garrison and Link 2000). Fishery removals
7 have the potential to remove and redirect energy, alter predator/prey relationships and community
8 structure, and change diversity.

9
10 The social and economic effects of the Alaska groundfish fisheries in the Bering Sea, Aleutian Islands,
11 and Gulf of Alaska are beyond the scope of this biological opinion; they will be addressed in the
12 Environmental Impact Statement that is being prepared on the FMPs (NMFS in prep.). Instead, the
13 following sections of this chapter will focus on the primary effects of the fisheries on water quality and
14 the biology of the marine ecosystem.

15 16 **6.5.1 Effects on water quality**

17
18 Most of the groundfish caught by shore-based vessels will be processed in seafood processing facilities in
19 the action area. The Environmental Baseline chapter of this biological opinion discussed the seafood
20 processing facilities that have been associated with the groundfish fisheries. As discussed in the baseline,
21 concern about the effects of fish-processing on water quality in Alaska has dated to the 1800s, but it
22 became a public policy issue after water quality deteriorated in coastal areas. However, the adverse
23 effects of this material tend to be highly local and usually depend on flushing rates and dispersal regimes
24 of the receiving waters. When discharges exceed the dispersion and biodegradation rates of the receiving
25 waters, they can build up, increase the biological oxygen demand of the receiving waters, and can
26 produce noxious smells. The waste can cause receiving waters to become anoxic, can elevate ammonia
27 levels, can smother benthic organisms, and attract scavengers such as gulls or rodents, which may cause
28 public health problems.

29
30 In 1998, the AKDEC and EPA established TMDLs for Udagak Bay (Beaver Inlet on Unalaska Island in
31 the Aleutian Islands) and King Cove lagoon in King Cove (on the Alaska Peninsula in the Aleutians East
32 Borough) because of the effects of seafood wastes on water quality in those water bodies (EPA 1998a,
33 1998b). In Udagak Bay, the AKDEC concluded that the Northern Victor Partnership facility *P/V*
34 *Northern Victor* produced seafood processing wastes (from Pacific cod, Pacific halibut, herring, walleye
35 pollock, salmon, and a variety of other fish) that created a waste pile deposit of settled solid residues
36 measuring at least 2.4 acres in area and 7 feet thick on the seafloor. ADEC concluded that the waste pile
37 exceeded Alaska's water quality standards for residues. For King Cove, the (ADEC) concluded that the
38 Peter Pan Seafoods facility created a waste pile covering 11 acres of seafloor to an average depth of 3
39 feet.

40
41 In 1998, AKDEC's list of impaired waters also included six additional water bodies in Cold Bay, Dutch
42 Harbor, and Kodiak that had been impaired by seafood processing, logging operations, military materiel,
43 or fuel storage. Although total maximum daily loads have not been developed for these facilities, the
44 effects of these facilities appear to be localized and are not expected to adversely affect threatened or
45 endangered species under NMFS' jurisdiction.

46
47 In addition to the facilities that have been associated with impaired waters, the Alaska Division of
48 Environmental Health, Seafood Processing and Development issues permits to seafood processors in four
49 general categories: canneries (retort processors), land-base processors, vessel processors, and direct-

1 marketing processors (Table 6.7). Each of these facilities produce fresh, frozen, salted, or formulated
2 seafood products aboard a large, floating vessels, with associated. The Alaska Division of Environmental
3 Health is primarily concerned with ensuring that facilities do not contaminate food sources and that
4 facilities properly manage sewage and waste.
5

6 In addition to the facilities listed in Table 6.7, the State of Alaska also issued seafood processing permits
7 to land-based processors in Emmonak,, False Pass, Nikiski, Nome, St. Paul, Sand Point, Savoonga,
8 Soldotna, Toksook Bay, and Whittier, Alaska. In addition, the State of Alaska issued permits to a large
9 number of vessel processors from other states; vessel-based processors located in Seattle, Washington,
10 constituted the majority of these processors. The effects of these facilities appear to be localized and are
11 not expected to adversely affect threatened or endangered species under NMFS' jurisdiction.
12

13 Discards and offal production can cause local enrichment and change in species composition if discards
14 or offal returns are concentrated there. Some evidence of those effects have previously been cited
15 (Thomas, 1994) in areas with inadequate tidal flushing (Orcas Inlet in Prince William Sound and in
16 Dutch Harbor) but not in the deepwater disposal site in Chiniak Bay of Kodiak Island (Stevens and
17 Haaga, 1994). Local ocean properties (water flow and depth) and amount of water discharged per year
18 could be important factors determining the effect of nearshore disposal on local marine habitat and
19 communities. Changes to the processing plant at Dutch Harbor have dramatically reduced the amount of
20 offal and ground discards discharged. Improved retention could be causing some increases in the amount
21 of local enrichment due to disposal of increased offal from shoreside processing of newly retained fish.
22 However, increase in offal production for the Bering Sea if all pollock, cod, rock sole and yellowfin sole
23 were to be retained would amount to an increase of about 6% and likely would not cause a change in
24 water quality.
25

26 With regards to listed species, therefore, it is not believe that water quality in the Action Area is
27 impacted in such a manner that it would jeopardize listed species, or adversely modify critical habitat for
28 Steller sea lions in a manner that would diminish its value for both survival and recovery of that species.
29

30 **6.5.2 Effects on benthic habitat**

31 Groundfish are generally associated with ocean bottoms. For example, in the action area, Pacific ocean
32 perch and other rockfish use sea floor habitats for cover and foraging. In the pursuit of groundfish
33 species, the fleet uses bottom trawl, pot, or longline gear that may have physical effects that damage or
34 degrade sea floor habitat. In particular, trawls have had documented effects on sea floor habitat and
35 biotic communities associated with that habitat. Trawls can increase turbidity that is likely to reduce or
36 eliminate epifaunal communities. Epifauna often play key roles in influencing the structure and stability
37 of benthic communities. They can modify benthic boundary flow characteristics which further influence
38 sediment characteristics and the deposition of larvae. These organisms increase the diversity of sea floor
39 habitat that provide refuges for different life stages of fish species, including fish species that are
40 commercially harvested. De Groot (1984) and Jones (1982) report that concern about the effects of trawls
41 on benthic communities dates from the late 1300s.
42

43
44 Despite this long history of concern, there has only recently been a focus on studying the effects of trawls
45 on benthic habitats and communities. Riemann and Hoffmann (1991) and Jones (1992) reported that
46 trawls adversely affect sea floor habitats by scraping and ploughing the bottom to depths of 30 cm as well
47 as resuspension of sediment and destruction of bottom communities. Bergman and Hup (1992) report that
48 a beam trawl gouges the sea floor to depths of at least 6 cm and the boards of otter trawls can create
49 gouges as deep as 15 cm. They provided lists of benthic organisms that experience population reductions

1 ranging from 10 to 65 percent.

2
3 Auster and Langton (1998) reviewed the indirect effects of fishing on essential fish habitat. They
4 indicated that all studies reviewed revealed immediate effects of fishing on species composition and
5 diversity and a reduction of habitat complexity. Short-term effects were a good indicator of long-term
6 effects, and recovery was variable depending on habitat type, life histories of component species, and the
7 natural disturbance regime. They also wrote that data are lacking on the spatial extent of fishing-induced
8 disturbance, the effects of specific gear types along a gradient of fishing effort, and the linkages between
9 habitat characteristics and the population dynamics of fishes. Trawling on sea floor habitat and benthic
10 communities in the GOA generally disturb sea floor habitats by displacing boulders, removing epifauna,
11 decreasing the density of sponges and anthozoans, and damaging echinoderms. However, the effect of
12 this disturbance on fish and other living marine resources is not known.

13
14 The Ecosystems Considerations sections of the annual SAFE reports have expressed concern about the
15 potential effects of gear on bottom habitat, but information on those effects is still very limited.
16 Nevertheless, the current condition of bottom habitat in these regions cannot be described with sufficient
17 detail to evaluate the overall effect of fishing gear on bottom habitat and associated marine communities.

18
19 In April 2000, the Council adopted part 1 of the HAPC initiative as Amendment 65/65 to the Bering
20 Sea/Aleutian Islands and Gulf of Alaska groundfish FMPs. These amendments will define all corals and
21 sponges as prohibited species. The purpose of these amendments are to prohibit a commercial fishery
22 from developing on invertebrates that provide important habitat for fish. Retention for personal use
23 would be allowed, but the sale, barter, trade of corals and sponges would be prohibited. Implementation
24 into regulation is expected early in 2001.

25 26 **6.5.3 Effects on the ecosystem**

27
28 The groundfish fisheries in the Bering Sea, Aleutian Islands, and Gulf of Alaska have direct effects on
29 fish population structure through the changes in the growth, mortality, production, and recruitment of
30 target fish populations and species caught as bycatch that result from fishery removals from individual
31 populations. Removing target species and species caught as bycatch could also have indirect effects on
32 other members of the marine ecosystem by changing predator/prey relationships and community
33 structure, biomass removal and redirection, and diversity.

34
35 The status quo groundfish fishery management regime has reduced spawning biomass for 17 individual
36 groundfish stocks, on average, to about 59% of the equilibrium unfished level of those stocks. In general,
37 fishing has the potential to influence ecosystems in several ways. Fishing may alter the amount and flow
38 of energy in an ecosystem by removing energy and altering energetic pathways through the return of
39 discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned
40 biomass may differ from those in an unfished system. Selective removal of species and/or sizes of
41 organisms has the potential to change predator/prey relationships and community structure. Fishing can
42 alter different measures of diversity. Species level diversity, or the number of species, can be altered if
43 fishing essentially removes a species from the system. Fishing can alter functional or trophic diversity if
44 it selectively removes a trophic guild member and changes the evenness with which biomass is
45 distributed among a trophic guild. Certain species, such as walleye pollock, are at a central position in
46 the food web and their abundance is an indicator of prey availability for many species. Fishing can alter
47 genetic level diversity by selectively removing faster growing fish or removing spawning aggregations
48 that might have different genetic characteristics than other spawning aggregations. Fishing gear may
49 alter bottom habitat and damage benthic organisms and communities.

1 A great deal of literature has been written on possible indicators of ecosystem status in response to
2 perturbations (e.g., Odum 1985). These indices can show changes in energy cycling and community
3 structure that might occur due to some external stress such as climate or fishing. For example, fisheries
4 might selectively remove older, more predatory individuals. Therefore, we would expect to see changes
5 in the size diversity spectrum (the proportion of animals of various size groups in the system), mean age,
6 or proportion of r-strategists (faster growing, more fecund species such as pollock) in the system. These
7 changes can increase nutrient turnover rates because of the shift towards younger, smaller organisms with
8 higher turnover rates. Total fishing removals and discards also provide a measure of the loss and re-
9 direction of energy in the system due to human influences. Total fishing removals relative to total
10 ecosystem energy could indicate the importance of fishing removals as a source of energy removal in an
11 ecosystem. Changes in scavenger populations that show the same direction of change as discards could
12 be an indicator of the degree of influence discards have on the system. Discards as a proportion of total
13 natural detritus would also be a measure that could indicate how large discards are relative to other
14 natural fluxes of dead organic material. Levels of total fishing removal or fishing effort could also
15 indicate the potential for introduction of non-native species through ballast water in fishing vessels.
16 Fishing practices can selectively remove predators or prey. Tracking the change in trophic level of the
17 catch may provide information about the extent to which this is occurring. Thus, we will use measures of
18 total catch, total discard, and information about the changing mean size of organisms to indicate the
19 potential of each of the present groundfish fishery management regime to impact ecosystem energy flow
20 and turnover.

21
22 Total catch and trophic level of the catch will also provide information about the potential to disrupt
23 predator/prey relationships via fishing down the food web through selective removal of predators. An
24 important factor affecting the trophic base is spatial distribution of the food. We will evaluate these
25 factors to determine the potential of the present groundfish fishery removal levels to disrupt
26 predator/prey relationships.

27
28 The scientific literature on diversity is somewhat mixed about what changes might be expected due to a
29 stressor. Odum (1985) thought that species diversity (number of species) would decrease and dominance
30 (the degree to which a particular species dominated in terms of numbers or biomass in the system) would
31 increase if original diversity was high while the reverse might occur if original diversity was low.
32 Genetic diversity can also be altered by humans through selective fishing (removal of faster growing
33 individuals or certain spawning aggregations). Accidental releases of cultured fish and ocean ranching
34 tends to reduce genetic diversity. More recently, there is growing agreement that functional (trophic)
35 diversity might be the key attribute that lends ecosystem stability. This type of diversity ensures there are
36 sufficient number of species that perform the same function so that if one species declines for any reason
37 (human or climate-induced), then alternate species can maintain that particular ecosystem function and
38 we would see less variability in ecosystem processes. However, measures of diversity are subject to bias
39 and we do not really know how much change in diversity is acceptable. Nonetheless, we suggest
40 possible impacts that the present federal groundfish fishery management regime may have on various
41 diversity measures.

42
43 Quantitative measures of some of the indicators mentioned above have been summarized to show the
44 projected change in the next five years under the present groundfish fishery management system. These
45 include total catch, trophic level of the catch, total discards, total groundfish biomass, diversity
46 (Simpson's richness index), trophic level of groundfish biomass, and amount of pollock or other forage
47 for the BSAI and GOA . We will address the possible impacts of the present fishery management regime
48 on (1) predator/prey relationships, (2) energy flow and redirection [through fishing removals and return
49 of discards to the sea], (3) diversity, and (4) competition.

6.5.3.1 Predator/ prey relationships and cascade effects

In an ecosystem, removing or reducing the size or age structure of one population will affect other populations in the ecosystem, which will respond to changes in predator-prey dynamics, the availability of resources, or to changes in the size of other populations in the ecosystem. If the species that is removed is relatively high in the trophic structure of an ecosystem, the effects of that removal can “cascade” through an ecosystem.

Clear indications of cascading effects of fishing are discussed by Pauly (1988) who reviews an example of an indirect effect of a destructive demersal fishery in the Gulf of Thailand. Pauly (1988) documented the collapse of target species, the virtual disappearance of rays and sawfish as a result of both bycatch and the loss of their food base, accompanied by a subsequent increase in snappers and squid. There seems to be a pattern in tropical demersal fisheries in which the reduction of the target stock is followed by an increase in squid, probably because the demersal eggs and very young of the squid are released from predation.

Evidence from other ecosystems presents mixed results about the possible importance of fishing in causing population changes of the fished species’ prey, predators, or competitors. Some studies showed a relationship, particularly for heavily fished areas, while others showed that the changes were more likely due to direct environmental influences on the prey, predator or competitor species rather than a food web effect. Thus, fishing does have the potential to impact food webs but each ecosystem must be examined to determine how important it is for that ecosystem.

Fisheries could alter the composition of the BSAI and GOA ecosystems in a number of ways, including enhancement of a prey species by removal of a predator, enhancement of one competitor by removal of another, and suppression of a predator by removal of prey. Examples of such effects may be more common for terrestrial species, but such effects are also observed in aquatic ecosystems. In addition to direct removal or reduction of a species, indirect consequences may accrue depending on the role of the species removed (e.g., keystone predator) and the method of removal (e.g., bottom trawling). For example, a recent report by Estes et al. (1999) suggests that killer whale predation has shifted from a diet that did not include sea otters prior to the 1990s to one that now includes sea otters. Barrett-Lennard et al. (1995) concluded that killer whale predation on a population of approximately 50,000 Steller sea lions could be one of the factors contributing to the current decline in abundance of Steller sea lions. At a minimum, we have to recognize the possibility that predation in the BSAI and GOA by killer whales on Steller sea lions, may be one of several factors inhibiting the current rate of recovery.

In the Environmental Baseline chapter, we described the dramatic changes that have occurred at the upper trophic levels of the marine ecosystem in the action area, partially caused by more than 200 years of commercial exploitation by fisheries. It would be reasonable to expect that dramatic reductions in the size of the cetacean populations in the BSAI and GOA would have effects similar to those reported from the Southern Ocean and cascade through the marine ecosystem of the action area. The extinction of Steller sea cows in the mid-1700s, had unknown impacts of the coastal and marine ecosystem of the action area, although the extinction of a species that consisted of such large animals would have had a significant effect on the structure of the coastal ecosystem. The reduction of bowhead and right whales in the Bering Sea in the 1800s could have made millions of tons of zooplankton available to other members of the marine ecosystem at that time, possibly with corresponding increases in their population size. The reduction of the fur seal

1 population of the Pribilof Islands in the early 1800s, again, in the early 1900s, and a third time
2 since the 1950s would have increased the biomass of their prey base. Similarly, the drastic
3 reductions of blue whales, fin whales, humpback whales, and sei whales in the 1950s and 1960s
4 would have made millions of tons of euphausiids and copepods available to other members of the
5 marine ecosystems.

6
7 It would be impossible to determine which species benefitted from the biomass that became
8 available to the marine ecosystem of the Bering Sea, Aleutian Islands, and Gulf of Alaska when
9 almost 350,000 large whales were killed in the North Pacific over a 30-year period. Populations
10 of planktivores like walleye pollock, Pacific cod, lanternfish, squid, sand lance, capelin, least
11 auklet (*Aethia pusilla*), crested auklets (*A. cristatella*), and parakeet auklets (*Cyclorhynchus*
12 *psittacula*) could have benefitted from the depletion of baleen whales in the region. For the same
13 reasons, populations of species like Risso's dolphin, Dall's porpoises, bottlenose whales, and
14 beaked whales could have benefitted from the depletion of sperm whales in the region. The NRC
15 (1996) believed the dramatic increase in the abundance of pollock during the 1960s was linked,
16 in some way, to the overexploitation of pinnipeds, cetaceans, and fish during the 1950s and
17 1960s. Although we can be fairly certain that the reductions in marine mammal populations in
18 the 1800s and the 1950s to 1960s changed the structure and composition of the biotic community
19 of the action area, it is impossible to determine how the community changed.

20
21 Since the 1960s, commercial exploitation of groundfish in the action area has significantly
22 reduced populations of some target species and species caught as bycatch. Over time, but prior
23 to the present fishery management regime, prior to the NPFMC and prior to the current FMPS
24 which are being considered in this biological opinion, the fisheries have depleted or overfished
25 yellowfin sole, Pacific Ocean perch, sablefish, walleye pollock, and Pacific halibut. These
26 depletions may have subsequently affected other members of the groundfish community and the
27 marine ecosystem although the direction or significance of such indirect effects cannot be
28 determined. However, under the present FMP and current fishery management regime, these
29 depleted fish stocks have increased. Within a fished community, species that are long-lived,
30 have delayed maturity, grow slowly, and have low reproductive output are more susceptible to
31 the direct effects of fishing than faster-growing species with early maturity. As a result, it is
32 reasonable to expect species like Pacific Ocean perch, sablefish, and other rockfish to take longer
33 to recover from the historical effects of fishing, which could potentially affect the structure of the
34 marine community for longer periods of time.

35
36 Evaluation of the present fishery management regime in the last 20 years does not show such
37 dramatic reductions of individual populations that occurred previously. Most of the work
38 evaluating predator/prey relationships in the EBS/AI and GOA regions in recent years has been
39 done in the eastern Bering Sea. Evidence from retrospective and modeling studies (Hollowed et
40 al. 1998, Livingston and Jurado-Molina, 2000) and examination of trophic guild changes
41 (Anderson and Piatt, 1999; Livingston et al., 1999) suggest that under the present groundfish
42 fishery management regime, there has not been clear evidence of fishing as the cause of species
43 fluctuations through food web effects. Multispecies models have shown that although
44 cannibalism can explain a large part of the density dependent part of the stock recruitment
45 relationship for pollock (that is the decline in recruitment observed at high spawner biomasses),
46 that most of the overall variability in stock and recruitment for pollock is not explained by
47 predation but appears to be more linked to climate events (Livingston and Methot 1998).

48
49 Pollock is a key prey species of many target and nontarget species in the Bering Sea and Gulf of

1 Alaska (Livingston 1989, 1994) and has a central position in the food webs of those ecosystems.
2 Modeling of predation on pollock in the eastern Bering Sea and Gulf of Alaska (Livingston and
3 Methot 1998, Livingston and Jurado-Molina 2000, and Hollowed et al. 2000) shows that
4 different predators may be the most important source of predation mortality during different time
5 periods. For example, Steller sea lion predation on pollock in the Gulf of Alaska was more
6 important in earlier years but the most important contemporary source of predation mortality on
7 pollock is now from arrowtooth flounder. Population levels of some of these predators such as
8 arrowtooth flounder appear unrelated to fishing removals but are more linked to environmental
9 forces that favor the production of these species (Hollowed et al., 1998). Similarly, the
10 fluctuations observed in species composition of trophic guilds (Livingston et al. 1999) do not
11 appear to be related to fishing removals of competitors or prey, when analyzed at the aggregated
12 level for the whole eastern Bering Sea. Measures of pelagic forage abundance under current
13 fishing practices indicate in the short term that from 2001 to 2005, that the fraction of pollock in
14 the total groundfish biomass is predicted to increase 6% in the BSAI and 29% in the GOA, in the
15 short term. Pollock biomass is predicted to increase 12% and 47% , respectively in these areas.
16 Stability of trophic level of the groundfish biomass and trophic level of the groundfish catch also
17 indicate there has not been a large change due to fishing in the groundfish community structure.
18 These have been relatively steady over the last 20 years and do not indicate successive depletion
19 of populations or fishing down the food web effects observed in more heavily fished ecosystems
20 of the world. This assessment is supported by the stock trajectories shown in Figure 6.16. The
21 stock trajectory in both fished and unfished scenarios indicate similar trends. Some species have
22 shown strong increases even when fished and declining fished stocks also declined when no
23 fishing was assumed, although the absolute biomass level was different.

24 25 **6.5.3.2 Effects on energy flow and balance**

26
27 As mentioned earlier, fishing may alter the amount and flow of energy in an ecosystem by
28 removing energy and altering energetic pathways through the return of discards and fish
29 processing offal back into the sea. The recipients, locations, and forms of this returned biomass
30 may differ from those in an unfished system.

31
32 A mass-balance model of the eastern Bering Sea (Trites et al. 1999) provides some information
33 on fishing removals relative to total system production and the distribution of biomass and
34 energy flow throughout the system in recent times. The trophic pyramids (distribution of
35 biomass at various trophic levels) for the eastern Bering Sea ecosystem in the 1950's before the
36 large groundfish fishery removals occurred and during the 1980's when the groundfish fishery
37 was operating, indicate that biomass and energy flow are distributed fairly well throughout the
38 system (see p. 28 of Trites et al. 1999). Apex predators at trophic level four do not contribute
39 much to the biomass of the eastern Bering Sea in both time periods and most flows are contained
40 in the lower three trophic levels. Differences in species composition of the biomass of trophic
41 level three and four were estimated from available data and show more flows involving small
42 pelagic fish relative to pollock in trophic level three in the 1950s and more flows through large
43 flatfish in the 1980s in trophic level four. Although there is evidence that small pelagic fish have
44 been more available in certain periods in the eastern Bering Sea, there is still uncertainty about
45 the historical levels of pollock abundance prior to research surveys, which began around 1979,
46 which could influence these views of relative contributors to the flow among trophic levels.

47
48 These mass-balance models show that the Bering Sea is a more mature (less disturbed) system
49 compared to other shelf systems. A more mature system is one that is less disturbed according to

1 Odum (1985). Total catch biomass (including non-groundfish removals) as a percentage of total
2 system biomass (excluding dead organic material known as detritus) was estimated was
3 estimated to be 1%, a small proportion of total system biomass. Fishery removal rates are based
4 in the most basic sense on the amount of surplus production (the excess of reproduction and
5 growth over natural mortality) (Hilborn and Walters 1992) for fish stocks. Because there is great
6 variability among stocks with regard to the amount of this excess production, it is likely more
7 important that removals stay within the bounds of each individual stock's excess production (a
8 topic that is considered in the individual stock impacts sections). From an ecosystem point of
9 view, total fishing removals are a small proportion of the total system energy budget and are
10 small relative to internal sources of interannual variability in production.

11
12 Fisheries can re-direct energy in the system through discarding and return of fish processing
13 wastes to the system. These practices take energy and potentially provide them to different parts
14 of the ecosystem relative to the natural state. For example, discards of dead flatfish or small
15 benthic invertebrates might be consumed at the surface by scavenging birds that would normally
16 not have access to those sources of energy. An analysis of the importance of these fisheries
17 practices on the BS/AI and GOA ecosystems was conducted by Queirolo et al. (1995), before the
18 improved retention requirements for pollock and cod were mandated. Total offal and discard
19 production at that time was estimated at only 1% of the estimate of unused detritus already going
20 to the bottom. No scavenger population increases were noted that related to changes in discard
21 or offal production amounts. The annual consumptive capacity of scavenging birds, groundfish
22 and crab in the eastern Bering Sea was determined to be over ten times larger than the total
23 amount of offal and discards in the BS/AI and GOA. Finally, it appeared that the main
24 scavengers of the fish processing offal, which primarily consisted of pollock, were also natural
25 pollock predators. Thus, energy flow paths did not seem to be re-directed in a large way due to
26 offal and discard production by groundfish fisheries.

27
28 Discard rates have dropped even further since the implementation of retention requirements for
29 all pollock and cod in groundfish fisheries. Managed groundfish species discards dropped below
30 10% of the total catch (down from about 15% in the EBS/AI and 20% in the GOA, respectively)
31 in 1998. The mandated retention of managed flatfish species (yellowfin sole and rock sole in the
32 BS/AI and shallow water flatfish in the GOA) in 2003, which make up the bulk of the remaining
33 discards of managed species, may cause the total discard amounts to decrease 28% in the BSAI
34 in the present groundfish fishery management regime from the year 2001 to 2005. Total discards
35 in the GOA are estimated to increase 3% in the status quo regime from 2001 to 2005 because
36 shallow water flatfish are not a dominant source of discards in the GOA (arrowtooth flounder,
37 grenadiers, pollock, and cod are the dominant species in the discards). The status quo regime has
38 removed the largest potential source of energy re-direction through discards with the improved
39 retention requirements in the eastern Bering Sea. Discards are estimated to decline to 7% of the
40 total catch in the BSAI but will remain constant at about 17% of the total catch in the GOA, a
41 reflection of the discard level observed in 1999. Combined evidence regarding the level of
42 discards relative to natural sources of detritus and no evidence of changes in scavenger
43 populations that are related to discard trends suggest that the present groundfish fishery
44 management regime has insignificant ecosystem impacts through energy removal and re-
45 direction.

46 **6.5.3.3 Effects on biological diversity**

47 Fishing can alter different measures of diversity. Species level diversity, or the number of
48
49

1 species, can be altered if fishing essentially removes a species from the system. Fishing can alter
2 functional or trophic diversity if it selectively removes a trophic guild member and changes the
3 way biomass is distributed within a trophic guild. Fishing can alter genetic level diversity by
4 selectively removing faster growing fish or removing spawning aggregations that might have
5 different genetic characteristics than other spawning aggregations. Large, old fishes may be
6 more heterozygous (i.e., have more genetic differences or diversity) and some stock structures
7 may have a genetic component (see review in Jennings and Kaiser 1998), thus one would expect
8 a decline in genetic diversity due to heavy exploitation.
9

10 Localized extinctions or depletions of stocks within species are common for freshwater and
11 anadromous species (i.e., salmonids). For marine species, there are no known extinctions due to
12 fishing. However, localized extirpations or depletions due to fishing have been observed in the
13 Irish Sea and stocks of tuna in the Atlantic. Examples of severe depletions include Icelandic
14 summer spawning herring which declined in the 1960s, Northwest Atlantic halibut which
15 declined in the early 1900s, northern cod which was closed in 1992, several long-lived sharks,
16 skates. However, in almost all cases, the fishing mortality rates on these local populations were
17 extremely high prior to the collapse of the stock. These type of extinctions could be thought of
18 as a decrease in species level diversity or the actual number of species in an area. Elasmobranchs
19 such as shark, skate, and ray species are vulnerable to fishing removals and improvements to the
20 groundfish fishery management regime have been proposed to provide a more precautionary
21 basis for the management of these species. Again, these effects have occurred prior to the
22 current management strategy being considered, prior to the current FMP. So while it can happen,
23 and has happened under conditions where management was not precautionary, extinctions due to
24 fishing under the current regime are not considered likely to occur. No fishing induced
25 extinctions have been documented in the last 30 years.
26

27 Taxonomic work on some fish species (e.g., skates) is still ongoing and little survey and
28 systematic work is being done on other ecosystem components such as benthic invertebrates that
29 could be impacted by fishing activities. Until some of these survey and taxonomic problems are
30 resolved, we are unable to fully assess the impacts of the status quo on species level diversity.
31 However, it is not believed that the level of uncertainty is significant enough to result in a
32 situation that could jeopardize listed species or adversely modify critical habitat.
33

34 Studies of other more heavily fished systems, such as the North Sea, Georges Bank, or Gulf of
35 Thailand have shown declines in diversity related to fishing and the diversity declines were due
36 to direct mortality of target species. Biomass diversity and evenness for trophic guilds was
37 investigated by Livingston et al. (1999) in the eastern Bering Sea in the current regime. There
38 appeared to be no evidence that groundfish fisheries caused declines in trophic guild diversity for
39 the groups. For example, the biomass of diversity in the pelagic fish consumer guild was close to
40 1 over the period of 1979 to 1993, a reflection of the dominance of pollock in the biomass of that
41 group. Diversity tended to decline when pollock biomass increased due to large year class
42 production. Other groups such as the benthic infauna consumer guild and the crab/fish consumer
43 guild had higher species biomass diversity than the pelagic fish consumer guild. Guild diversity
44 changes were again seen when a dominant member changed in abundance. The abundance
45 changes of those species were mostly related to recruitment changes and not to fishing. There
46 appeared to be no fishing-induced changes in functional (trophic) diversity in the status quo
47 alternative. Functional (trophic) diversity indicators using forecasts of groundfish biomass in the
48 status quo alternative from 2001 to 2005 indicate an 8% decline in the diversity of groundfish
49 biomass in the BSAI and a 3% increase in groundfish biomass diversity in the GOA. The

1 decrease in the BSAI is primarily due to the increased dominance in pollock biomass in that
2 region while the GOA diversity change is smaller and not linked to a particular species. Thus,
3 there appears to be no fishing-induced changes in functional diversity.
4

5 Also, evidence so far in highly fished areas such as the North Sea suggests that there is little
6 evidence of genetically induced change in selection for body length in cod after 40 years of
7 exploitation. Genetic diversity has not been assessed in the status quo groundfish fishery
8 management regime here in the BSAI and GOA but we can infer that heavy exploitation of
9 certain spawning aggregations and heavier exploitation on older, more heterozygous individuals
10 would have the tendency to reduce genetic diversity in fished versus unfished systems. Thus,
11 some change in genetic diversity has possibly occurred in the BSAI and GOA but the magnitude
12 of the impacts are not known. The North Sea work indicates the impacts might be minimal.
13 Genetic assessment of pollock populations and subpopulations in the North Pacific shows some
14 genetic differences between stocks but has not demonstrated any genetic variability across time
15 within stocks that might indicate fishing influences (Bailey et al. 1996).
16

17 Therefore, in summary, the effects of fishing on biological diversity in the Action Area that
18 might somehow result in a decreased foraging base, or ability of a listed species to forage, have
19 indicated the following: there appears to be no fishing-induced changes in functional (trophic)
20 diversity; and genetic differences between stocks have not demonstrated any genetic variability
21 across time within stocks that might be attributed as an effect of fishing.
22

23 **6.6 Response of Threatened and Endangered Species**

24

25 In this biological opinion, we established that the various elements of the FMPs guide allocative
26 decisions and produce annual catch specifications. The intended consequence of these catch
27 specifications is to obtain the optimum yield for target groundfish species. TACs based on this
28 management strategy have been in place since the late 1970s and early 1980s and can be expected to
29 continue into the future. The consequence of the groundfish exploitation strategy is a reduction in the
30 spawning biomass (per recruit) of the target species to 40% of their unfished level. This exploitation
31 strategy is expected to continue and can be expected to have an effect on the marine community by
32 changing the demographic parameters of the target fish populations (growth, mortality, production, and
33 recruitment of target fish populations) and species caught as bycatch.
34

35 The relevant question is whether this stock-wide reduction in biomass has had an adverse effect on listed
36 species by decreasing the effective carrying capacity for that species. In other words, does the
37 continuous removal of target species at a conservative annual rate (in the single-species concept), the
38 cumulative reduction of their biomass to about half of unfished levels, and the alteration of their age
39 structure and geographic distribution affect listed species which rely upon this resource for survival and
40 recovery in the wild? Figure 6.20 schematically illustrates the potential effects of competition on the
41 carrying capacity of a predator such as Steller sea lions. However, there is no available information to
42 determine the appropriate location, and relationships of the curves. We have previously stated the
43 uncertainties with historic groundfish biomass estimates, listed species population estimates and foraging
44 rates, and the effects of multiple regime shifts. NMFS has conducted an exhaustive search of the
45 literature, consulted with internal and external experts, and performed a variety of new analyses to
46 determine the effects of all of these competing factors on listed species. We find no significant, relevant
47 evidence that the current exploitation strategy (which reduces the biomass to between 40 and 60% of the
48 predicted unfished biomass) adversely affects listed species by reducing their likelihood for survival and
49 recovery in the wild. However, it is our opinion that biomass reductions of important groundfish species

1 below 40% of their unfished level would not insure the protection of listed species or their environment.
2 The details of this conclusion will be discussed specifically for each listed species below.
3

4 **6.6.1 Steller sea lions**

5
6 In the Status of the Species and Environmental Baseline chapters of this opinion, we established that the
7 endangered western population of Steller sea lions have been declining throughout their range for almost
8 three decades. The population is approaching a 90 percent decline. Prior to the early 1970s, the primary
9 causes of the decline may have been commercial harvests, entanglement of juvenile sea lions in
10 commercial fishing gear, and intentional shooting by fishermen. However, since 1991 these effects have
11 been nearly eliminated, yet the overall rate of decline has been a relatively constant 4 percent per year.
12 The pertinent question now is what is causing this current decline?
13

14 At present, the leading hypothesis to explain the *continued* decline of the western population of Steller
15 sea lions is primarily the nutritional stress of juveniles and to a lesser extent adult females (Merrick et al.
16 1987, Pitcher et al. 1998, Rosen et al. 2000a, Alaska Sea Grant 1993). Such nutritional stress indicates
17 decreased foraging success, potentially as a consequence of environmentally-driven changes in prey
18 availability, but also as a consequence of competition with the BSAI and GOA commercial groundfish
19 fisheries. As described earlier in this chapter, the groundfish fisheries reduce prey availability on several
20 scales, resulting in range-wide, regional, and local depletion of prey. Fishing activity may also preclude
21 some sea lions from certain important foraging areas simply by disturbance, or the presence of fishing
22 vessels, gear, and activity. Since sea lions and the fisheries may well target the same aggregations of
23 prey, such interference may reduce foraging success even in when local prey are relatively abundant.
24

25 Juvenile Steller sea lions are particularly vulnerable to reductions in prey availability because of their
26 inexperience at foraging (compared to adults), have relatively greater metabolic demands, are more
27 susceptible to the rigors of seasonal climatic changes, and are more vulnerable to the risks associated
28 with additional foraging effort (e.g., predation by killer whales). That is, juveniles experiencing reduced
29 foraging success would have to increase their foraging time and energy expended, and by doing so would
30 be at greater risk of predation. As the energy costs of foraging increased, they would be less likely to
31 meet their energetic needs. If they are unable to do so, then their physical condition will deteriorate. As
32 their condition deteriorates, their ability to forage and avoid predators would be compromised, resulting
33 in a self-reinforcing downward spiral. The consequence would be a reduced likelihood of survival due to
34 starvation, predation, or disease. As indicated by York (1994) the portion of juveniles lost to the
35 population need not be large (10% to 20%) to result in a population decline.
36

37 Adult, female sea lions are also vulnerable to reductions in prey availability because they are required to
38 forage not only for themselves, but also for their offspring. Mature adult females may be pregnant and
39 therefore facing the demands of a growing fetus, and at the same time may be nursing offspring already
40 born. The females that are most successful are those that contribute most to the future gene pool; i.e.,
41 produce and rear pups that survive and eventually produce pups of their own. Whereas the challenge for
42 juvenile sea lions is survival, the challenge for adult females is to maximize their reproductive
43 contribution to the population. As the overall reproductive contribution of adult females is a function of
44 their survival and reproduction, and as their survival and reproduction may be affected by their
45 nutritional condition, adult females are likely vulnerable to reductions in prey availability. With
46 reductions in local prey availability, females may be required to commit more energy to foraging (i.e.,
47 greater energy expenditure) or may be required to conserve their energy by decreasing their contribution
48 to their offspring, or by compromising their own condition. If they compromise their contribution to
49 their offspring, then those offspring may be less likely to survive. If they compromise their own

1 condition, then they may reduce the likelihood of their own survival or future reproduction. At present,
2 we are unable to measure adult survival to determine to what extent it may be compromised by existing
3 conditions, but as described in Chapter 4 on the Status of the Species, we have seen clear evidence that
4 the reproductive effort and success of adult females has been compromised.

5
6 The survival and reproductive success of individual adult males may also be compromised by decreased
7 availability of prey. However, due to the polygamous reproductive system of Steller sea lions, the effects
8 on adult males may not be significant with respect to the whole population, as one male may successfully
9 impregnate multiple females. Nevertheless, as rookeries decline in size to smaller and smaller numbers,
10 the potential for adverse genetic effects may increase, in part due to reductions in the number of males
11 successfully contributing to reproduction.

12
13 Reductions in localized prey availability for prey-limited species must, then, affect the two primary
14 determinants of population growth for a closed population, birth and survival (or mortality). In the
15 absence of emigration or immigration, these two life table parameters determine the growth rate of the
16 population which, for the western population of Steller sea lions has been negative for over two decades.
17 As a consequence, the mean number of animals at rookeries and haulouts also continues to decline. In
18 addition to a decrease in the number of animals at local sites, secondary or compounding factors may
19 come into play that hasten the local populations to complete abandonment or extinction. Steller sea lions
20 are gregarious animals and may, at some point, simply abandon a site if the number of animals using the
21 site reaches some unacceptable low number or density. Similarly, as local rookery populations dwindle,
22 the potential for deleterious genetic consequences may increase, as the population consists of fewer and
23 fewer numbers of successful breeding age animals. Smaller local populations may also be more
24 susceptible to rare and random events (e.g., oil spills, landslides) that could drive a local population to
25 extinction. Such phenomenon are not merely hypothetical, but have already begun to occur. Certain
26 haulout sites in the GOA, for example, have been partially abandoned. The proposed closure at Cape
27 Barnabas was strongly contested in 1998 and 1999 because few animals continue to use the site and they
28 appear to do so only seasonally.

29
30 Population viability analyses conducted by Merrick and York (1994) indicate that the next 15-20 years
31 may be crucial for the Steller sea lion, if the decline continues. They suggested that within this time
32 frame, the number of adult females in the Kenai-to-Kiska region could drop to less than 5,000.
33 Extinction rates for rookeries or clusters of rookeries could increase sharply in 40 to 50 years, and
34 extinction throughout the entire Kenai-to-Kiska region could occur in the next 100-120 years. Because
35 Steller sea lions are a long-lived, slow-growing species, they probably cannot recover from their current
36 decline by more than 8% to 10% per year (under ideal conditions).

37
38 With reduced foraging conditions and declining local populations, the regional centers of population
39 distribution may shift. The recent count data suggest that the areas experiencing the worst relative
40 declines are at the edges of the western population. While the overall decline has remained relatively
41 consistent at about 4 percent per year since 1991, counts at some of the trend sites in the eastern and
42 central GOA have continued to decline by 10% to 15% per year. The most recent counts in the western
43 Aleutians declined severely between 1998 and 2000. The western Aleutian Islands results may indicate
44 that animals have died, moved, or are spending more time in the water. But the overall result is that the
45 center of this declining population is shifting back to the center of the range in the eastern Aleutian
46 Islands and western GOA. As a consequence, the population may be approaching a range contraction as
47 a result of it collapsing towards the middle.

48
49 Finally, the response of sea lions to an increase in prey may also not be apparent for some years, although

1 an abatement of the decline of sea lions should show up much sooner in the annual pup counts. Counts
2 of nonpups on the rookeries may not increase until juvenile survival improves and those animals reach
3 reproductive age. More immediate changes in number of pups born may be observed if conditions
4 improve significantly for adult females, but the recovery of the population will require improved juvenile
5 survival as well as increased pup production. Again, Merrick and York (1994) indicated that if the
6 decline of the western population is not abated and its rate of increase is not improved immediately, the
7 population could become extinct within the foreseeable future.

8
9 The western population of Steller sea lions has declined for the past 20 years due to a combination of
10 environmental and fisheries-related factors. Under the current FMPs and resulting fisheries, we can
11 expect this population to continue its decline. Even if fishery related impacts to Steller sea lions were
12 eliminated completely, we would expect the decline to continue as a result of environmental pressures
13 that are also acting upon, and reducing, the survivability of this population. We can continue to expect
14 reduced reproductive success in adult female Steller sea lions and reduced survival of juvenile sea lions.
15 However, we are still required under the ESA to remove any possibility of jeopardy and adverse
16 modification from the effects of the commercial fisheries. Currently the western population of Steller sea
17 lions is declining at between 4-7% per year. Removal of the fishery contribution to this decline is
18 significant, will enhance the recovery of the species, but will not, necessarily reverse the decline.

19
20 In previous biological opinions and the Status of the Species and Environmental Baseline chapters of this
21 biological opinion, we noted the increased abortion rates of adult female sea lions in the action area,
22 which would be the normal response of an adult female under nutritional stress had to choose between
23 nurturing an existing pup or a fetus. This would reduce the reproductive rate of the western population of
24 Steller sea lions. We also noted the increased death rate of juvenile Steller sea lions. We believe that
25 pups that are being weaned and juvenile sea lions that have been weaned are dying in the face of
26 competition from the groundfish fisheries when they are unable to locate prey in the densities they need
27 to sustain themselves. This reduces the population size of Steller sea lions and effectively reduces their
28 reproductive rate.

29
30 Under normal circumstance, the life history of Steller sea lions would protect them from short-term
31 declines in the reproductive success of adult females or the survival of juvenile sea lions. Steller sea lions
32 are long-lived species with overlapping generations, a life-history strategy that protects them from short-
33 term, environmental fluctuations. Their life history strategy would protect sea lions populations from
34 variable survival and mortality rates caused by short-term phenomena like ENSO. However, this life-
35 history strategy cannot protect Steller sea lions from changes in birth rates and juvenile survival that
36 continue for two or three decades. The combined effects of reduced reproductive success and juvenile
37 survival would be expected to reduce the size of the Steller sea lion population and continue their current
38 rate of decline. Given the current size of the western population of Steller sea lions, further reductions in
39 their reproductive success and juvenile survival can be expected to appreciably reduce their likelihood of
40 survival and recovery in the wild.

41
42 There is general scientific agreement that the decline of the western population of Steller sea lions in the
43 1990s resulted primarily from declines in the survival of juvenile Steller sea lions and lowered
44 reproductive success in adult females. There is also general scientific agreement that both of these
45 problems have a dietary or nutritional component (Merrick et al. 1987, Pitcher 1998, Rosen et al. 2000a,
46 Alaska Sea Grant 1993). There is much less agreement on whether fishery-induced changes in the forage
47 base of Steller sea lions have contributed to and continue to contribute to the decline of Steller sea lions.
48 The National Research Council (1996), based on the best scientific and commercial information
49 available, concluded that the groundfish fisheries managed under the two FMPs may adversely affect

1 Steller sea lions by (a) competing for sea lion prey and (b) affecting the structure of the fish community
2 in ways that reduce the availability of alternative prey.
3

4 **6.6.2 Critical habitat for Steller sea lions** 5

6 All major rookeries and haulouts of the western population of Steller sea lions have critical habitat
7 associated with them that extends 3,000 feet (0.9 km) landward 3,000 feet (0.9 km) above the major
8 rookery or haulout, and extends 20 nm (37 km) seaward in State and Federally managed waters. Specific
9 areas that have been included in the critical habitat designation include the Shelikof Strait area in the
10 Gulf of Alaska between the Alaska Peninsula and Tugidak, Sitkinak, Aiaktilik, Kodiak, Raspberry,
11 Afognak and Shuyak Islands, the southwestern tip of Tugidak Island, Cape Douglas, Shuyak Island, the
12 Bogoslof area in the Bering Sea shelf , and the Seguam Pass area.
13

14 As discussed in the Status of the Species chapter of this biological opinion, the area that is designated as
15 critical habitat was determined using information on the life history patterns of Steller sea lions,
16 particularly land sites where sea lions haul out to rest, pup, nurse their pups, mate, and molt. The area
17 that is designated as critical habitat for Steller sea lions was also designed to include the primary foraging
18 areas for Steller sea lions during periods of their annual life cycle that are critical to their reproduction:
19 the areas used by adult females during the latter stages of pregnancy and when they are weaning pups;
20 the areas used by pups when they begin to feed independently; and the areas used by juvenile sea lions.
21 As such, the critical habitat that has been designated for Steller sea lions was designed to protect the prey
22 base around sea lion rookeries and haulouts that is necessary for adult, female sea lions to survive and
23 successfully reproduce and for juvenile sea lions to survive.
24

25 The value of the marine portions of critical habitat that has been designated for Steller sea lions will be
26 determined by the abundance and distribution of prey species. The abundance of prey within these
27 foraging areas, over time, would determine the number of predators they could support in that time; as
28 the abundance increased, the area would be able to support more predators, as the abundance decreased,
29 the area would be able to support fewer predators. Similarly, the distribution of prey species will
30 determine whether prey are available to foraging sea lions and will determine whether they can forage
31 successfully. Factors that would determine an area's value to predators like Steller sea lions include the
32 distance of prey from shore, the depth of prey in the water column, the distribution and abundance of
33 prey, and the dispersal of prey over time and space.
34

35 In the Environmental Baseline chapter, we used the term “environmental carrying capacity” (the
36 relationship between the distribution and abundance of prey and the number of predators an area could
37 support at a particular time) to represent the value of critical habitat for Steller sea lions. Even without
38 the presence of humans, other species compete with Steller sea lions for food in their designated critical
39 habitat. Adult walleye pollock, arrowtooth flounder, Pacific cod, northern fur seals, spotted seals, harbor
40 seals, and numerous species of seabirds compete for small pollock in the action area; harbor seals
41 compete with sea lions for larger pollock; orcas, humpback whales, gulls, and pinnipeds compete with
42 sea lions for species like herring and capelin; and there are similar competitive interactions for species
43 like salmon, rockfish, and sablefish.
44

45 Based on the information available, it is also reasonable to believe that competition exists between the
46 groundfish fisheries and non-human members of the marine ecosystem. However, the management
47 structure that is created by the FMPs, the information that is gathered to assess the distribution and
48 abundance of the various groundfish species, and the process that is used to specify annual total
49 allowable catches are designed to protect populations of target groundfish species, bycatch, and the

1 related marine ecosystem. Management actions that are applied during the fishing season have also
2 furthered these purposes. Notwithstanding these protections, our current review suggests that the fishing
3 power of the groundfish fleet and individual vessels can deplete the groundfish biomass on small, spatial
4 and temporal scales that would be expected to reduce the availability of groundfish to other, non-human
5 consumers under current management approaches.
6

7 We previously noted the amount of the groundfish harvest that occurs in critical habitat that has been
8 designated for Steller sea lions. Between 1995 and 1999, about 49% of the total groundfish harvest in
9 the BSAI was taken from critical habitat designated for Steller sea lions. About 14% of this catch was
10 taken within 20 nm of sea lion rookeries and haulouts in the Bering Sea and 10 nm of rookeries and
11 haulouts in the Aleutian Islands area. The pot sector was the most concentrated in critical habitat (up to
12 81%), followed by the trawl sector, and then the hook-and-line sector. However, the magnitude of the
13 trawl catch in critical habitat was much greater than pot, about 430,000 mt as compared to about 14,000
14 mt, in 1999. Also in 1999, hook-and-line catch was more dispersed outside of critical habitat on average,
15 and accounted for about 75,000 mt taken outside of critical habitat and about 25,000 mt inside. The
16 possible effects of these other gear types were dwarfed by the biomass removed by the trawl sector in
17 1999, which removed 1,286,852 mt. In the BSAI, the portion of each groundfish catch taken in 1999
18 from critical habitat ranged from 1% for the yellowfin sole fishery to 74% for the sablefish fishery. By
19 amount, the tonnage removed from critical habitat in each fishery ranged from 657 mt for yellowfin sole
20 and 332,251 mt for pollock. The portion of BSAI pollock, cod, and Atka mackerel fisheries combined
21 from critical habitat has increased from 12% in 1980 (about the beginning of the joint-venture fishery) to
22 a peak of about 66% in 1995, and then dropped to 37% in 1999.
23

24 In 1998, the NPFMC recommended changes to the Atka mackerel fishery. This fishery occurs almost
25 exclusively in the Aleutian Islands region west of 170°W and south of 55°N (Figs. 2.4 or 4.7). This
26 region (within the US EEZ) consists of 1,001,780 km² of ocean surface, of which 104,820 km² is Steller
27 sea lion critical habitat (approximately 10 percent). The purpose of the recommended changes was to
28 reduce the potential for competition between the Atka mackerel fishery and Steller sea lions. The
29 evidence for such competition was based on catch-per-unit-effort data from various locations in the
30 Aleutian Islands. The data suggested that local harvest rates were much larger than the overall target
31 rates for the entire Aleutian Island region. Since most of the Atka mackerel catch came from Steller sea
32 lion critical habitat (about 80% in 1995-97), the evidence for locally high harvest rates raised concerns
33 that the fishery might be depleting local prey availability in areas considered critical for sea lion
34 recovery.
35

36 The changes implemented in 1999 split the Atka mackerel fishery into two equal seasons (by TAC) and
37 imposed spatial restrictions on the distribution of the fishery. The spatial measures reduced the
38 allowable catch in critical habitat from about 80% to levels at or below 40% over the period from 1999 to
39 2002. Prior to 1999, a total of 17,120 km² (or 16%) of Aleutian Island critical habitat was closed to all
40 trawl fisheries year round (10-nm trawl exclusion zones around important rookeries and haulouts). As a
41 result of the Atka mackerel measures implemented in 1999, an additional 4,600 km² (an additional 4% of
42 critical habitat) was closed to all trawl fisheries from January-April each year (between 10 and 20 nm
43 around the rookeries on Seguam and Agligadak Islands). These measures also implemented a phased-in
44 reduction in Atka mackerel catches in critical habitat compared to historic patterns; by 2002, the
45 measures should reduce Atka mackerel catches in critical habitat by about 50% from historic levels and
46 would allow 40% of the Atka mackerel catch from inside critical habitat.
47

48 The NPFMC also developed BSAI measures for the pollock fishery to 1) avoid competition during the
49 early winter season by closing that period to pollock trawling, 2) avoid competition around rookeries and

1 major haulouts by closing those areas to pollock trawling, 3) disperse the fisheries spatially, and 3)
 2 disperse the fisheries temporally. In addition, the Aleutian Islands region was closed to pollock fishing
 3 (22,000 mt were caught in the Aleutian Island region in 1998; slightly more than 2% of the BSAI pollock
 4 catch). These measures resulted in a total of 210,350 km² (54%) of critical habitat closed to the pollock
 5 fishery (BSAI and GOA combined). The portion of critical habitat that remained open to the pollock
 6 fishery consisted primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA
 7 and parts of the eastern Bering Sea special foraging area.

8
 9 On the eastern Bering Sea shelf, both the catches of pollock and the proportion of the total catch caught
 10 in critical habitat have been reduced significantly since 1998 as a result of the NPFMC actions:
 11
 12

Estimated pollock catches (mt) and percent caught in the Sea Lion Conservation Area in the eastern Bering Sea			
Months	1998	1999	2000
January-March	441,000 (88%)	222,300 (57%)	156,800 (39%)
January-December	642,100 (60%)	372,800 (39%)	

13
 14
 15
 16
 17
 18
 19 The NPFMC measures taken to implement the RPAs also accomplished some spatial and temporal
 20 spreading of the pollock fishery in the eastern Bering Sea (Figs. 5.1 and 5.2). In 1998, prior to the
 21 measures being implemented, the pollock fishery was concentrated into 2 seasons, each approximately 6
 22 weeks in length in January-February and September-October (Fig. 5.3). Ninety-four percent of the
 23 pollock catch was taken in these four months (45% in January-February and 49% in September-October).
 24

25 In 1999, the fishery was dispersed into March (reducing the percent taken in February) and into August.
 26 Small amounts of pollock were taken in April-July. Thus, the 1999 fishery was dispersed only slightly
 27 better than the 1998 fishery (Figs. 5.1 and 5.2). In 1998, daily catch rates averaged over 8,100 mt/day,
 28 and peaked at over 21,300 mt/day. In 1999 and 2000, average daily catch rates for January-March
 29 declined about 22% to 6,200 mt/day and 6,400 mt/day, respectively; daily maximums were 15,400
 30 mt/day and 12,500 mt/day, respectively. These changes resulted from a combination of the RPAs and the
 31 implementation of cooperatives under the American Fisheries Act (see below).
 32

33 For both the pollock and Atka mackerel fisheries, the NPFMC measures did not modify the methodology
 34 of determining the acceptable biological catch (ABC). However, as a consequence of these measures, the
 35 percent catch of all species in critical habitat decreased from about 53% before 1999 to 34% in 1999.
 36 The underlying assumption was that the total amount of the catch was not an issue, and that as long as
 37 certain periods (early winter) and areas (around rookeries and major haulouts) were protected from
 38 competition, and the catch was otherwise dispersed temporally and spatially, the fisheries would not
 39 jeopardize the Steller sea lion or other listed species, or adversely modify Steller sea lion critical habitat.
 40

41 In the GOA, analysis of the historic distribution of catch inside and outside of critical habitat is more
 42 complicated than in the BSAI. Much of the GOA fisheries are prosecuted by a small boat fleet that has
 43 low or no observer coverage. These smaller boats are more likely to fish inside critical habitat for safety
 44 considerations. However, the larger boats, which are more likely to fish further offshore, also have a
 45 higher observer coverage. The result is that analyses of fishing effort are often skewed by larger vessels
 46 and catch from critical habitat is underestimated. The magnitude of this error is unclear, but nearly all

1 boats under 60 ft may operate within 20 nm from shore, in areas designated as critical habitat.

2
3 In the period from 1995-1999, the average catch from critical habitat for all sectors was 54% of the total
4 catch, about 48% of the total catch was within 20 nm of listed rookeries and haulouts. The pot sector was
5 the most concentrated in critical habitat (up to 71%), followed by the trawl sector, and then the hook-and-
6 line sector. However, as in the BSAI, the magnitude of the trawl catch in critical habitat was much
7 greater than pot, about 100,000 mt as compared to about 10,000 mt in 1999. Also in 1999, hook-and-line
8 catch was more dispersed outside of critical habitat on average, and accounted for about 20,000 mt of
9 catch outside of critical habitat and about 7,500 mt inside. Again, the possible effects of these other gear
10 types are dwarfed by the magnitude of biomass removals by the trawl sector; trawl catch in 1999 was
11 180,000 mt.

12
13 The potential effects of the GOA pollock fisheries were also addressed in the December 3, 1998
14 Biological Opinion. NMFS issued RPAs on October 15, 1999, that were designed to avoid jeopardy and
15 adverse modification for this fishery through 2002. For the GOA, the RPAs were intended to disperse
16 the pollock fishery temporally into four discrete seasons dispersed through the period from January 20 to
17 November 1. For 1999, little temporal dispersion was accomplished (Fig. 5.5). For 2000, these four
18 seasons were to begin January 20, March 15, August 20, and October 1. The catch was dispersed
19 accordingly.

20
21 For the GOA pollock fishery, the RPAs were intended to achieve two objectives with respect to spatial
22 dispersion. The first was to reduce pollock catches from around significant rookeries and haulouts by
23 requiring that fishing occur outside 10 nm from these areas, and the second was to distribute the seasonal
24 catches according to the seasonal pollock biomass distributions by area. In the GOA, survey and fishery
25 data suggested that winter pollock fishing effort could be higher in Shelikof Strait (part of critical
26 habitat) than had previously been observed. Surveys indicated that as much as 50% of the exploitable
27 biomass of pollock in the GOA was inside Shelikof Strait in March, yet the recent pre-RPA winter GOA
28 fishery did not catch 50% of its pollock from that area. Instead, the fishery worked principally in other
29 parts of critical habitat, presumably with less available biomass, but with other advantages, such as
30 proximity to ports. Therefore, fishing effort may have been disproportionately large in some portions of
31 critical habitat and considerably lower in others (e.g., Shelikof Strait). To distribute the pollock catch
32 according to the pollock distribution, the NPFMC established a separate Shelikof Strait management area
33 (combined areas 621 and 631) and allocated approximately 50% of the A and B season quotas to it. This
34 essentially shifted effort from one part of critical habitat to another to more closely match the winter
35 biomass distribution. Because of this, pollock catches from critical habitat in the A and B seasons would
36 not be expected to decline as a result of the RPAs. During the C and D seasons, the RPAs allocated
37 TAC by fishery management area.

38
39 Pollock catches and the percent of catch removed from critical habitat in the GOA increased in 1999 and
40 2000 relative to 1998 (see below). Pollock catches during January-March from critical habitat have
41 increased from almost 20,000 mt to over 34,000 mt, and the proportion caught in critical habitat
42 increased from 70% to 97%. As stated above, this is not a surprising result since the Shelikof Strait area
43 (critical habitat) was allocated over half of the GOA pollock TAC during the A and B seasons.
44

Estimated Pollock Catches (mt) and Percent Caught in the Steller Sea Lion Critical Habitat in the Gulf of Alaska			
Months	1998	1999	2000
January-March	19,900 (70%)	31,700 (88%)	34,100 (97%)
January-December	99,700 (79%)	75,600 (82%)	

Contrary to the EBS, the GOA pollock fishery has generally become increasingly concentrated in smaller areas (Fig. 5.4).

In 1999, the portion of each groundfish catch taken from GOA critical habitat ranged from 5% for the other rockfish fishery to 81% for the pollock fishery. By amount, the tonnage removed in each GOA fishery ranged from 89 mt for Atka mackerel and 77,663 mt for pollock. The portion of the GOA pollock and cod fisheries combined from critical habitat has increased from 19% in 1980 to 65% in 1999. Management measures were implemented in 1999 to disperse the GOA pollock fisheries spatially and temporally as required by the 1998 Biological Opinion RPA. Before 1999, the catch of all species averaged about 55% in critical habitat; in 1999, the catch was about 52% in critical habitat.

In the Environmental Baseline and earlier in this chapter, we presented data that showed that the groundfish fisheries harvest fish species that form the principle prey of Steller sea lions. Based on these data, we concluded that Steller sea lions and fishermen actively demand a common resource and that the fisheries reduce the availability of that common resource to other consumers. The groundfish fisheries reduce the abundance or alter the distribution of several significant prey species, such as walleye pollock, Pacific cod, and Atka mackerel. Earlier in this chapter, we also noted that fisheries can cause dense schools of prey species to scatter, which affects the foraging behavior of marine mammals and seabirds that target aggregated prey. Repeatedly causing fish schools to scatter and reducing their density reduce the value of the foraging areas to Steller sea lions by increasing the amount of time and energy sea lions would have to expend to feed on available prey.

The effects described in section 6 indicate that the fisheries as currently constituted, including the conservation measures put in place in recent years, reduce the abundance of prey within local foraging areas and alter the distribution of groundfish prey in ways that can reasonably be expected to reduce the foraging effectiveness of sea lions. The reduction in foraging success affects individual animals, reducing the likelihood of their survival and successful reproduction. In turn, reductions in survival and reproduction perpetuate the decline of the population and reduce the likelihood of recovery in the wild.

6.6.3 Summary of Effects on Steller Sea Lions

Following is a summary of the effects of the action. These effects in combination with the environmental baseline form the basis for the conclusion and determine what actions are necessary to comply with section 7 (a)(2). Based on the complexity of the effects analysis this overview is intended to review the most essential elements of this chapter’s explanation of the potential effects of this federal action on listed species. Since Steller sea lions are the species most likely to be impacted by these fisheries much of the focus on effects is specific to that species.

The ESA defines impacts on listed species as “take” (16 USC § 1532(19)). “Take” is further defined as to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any

1 such conduct” and does not require that actual death occur or that the species population declines.
2 Additionally, the FWS further defines “take” to include significant habitat modification or degradation
3 where it actually kills or injures wildlife by significantly impairing essential behavioral patterns,
4 including breeding, feeding, and sheltering (50 CFR § 17.3(c)). No federal agency may authorize an
5 action which would result in the “take” of an ESA- listed species without having an “incidental take
6 permit” authorized under section 9 of the ESA. However, any authorized “take”, which is cumulative,
7 cannot result in the action jeopardizing the continued existence of a listed species. Consequently, in
8 coming to a conclusion under ESA, the effects analysis in a biological opinion must examine the action
9 based on these criteria. If take causes effects on the species that exceed the jeopardy or adverse
10 modification standard, then the measure would have to be modified by reasonable and prudent
11 alternatives to comply with section 7 (a) (2). NMFS has demonstrated through the discussion in earlier
12 sections that this action is likely to result in harm to Steller sea lions by competing for prey, harassing
13 the animals because of vessel traffic, and result in some direct mortality of Steller sea lions due to
14 entanglement in fishing gear. Specifically, there are 4 primary effects categories: effect of global
15 biomass levels, effects of disturbance, and effects of temporal and spatial concentration of fishing.
16

17 **FMP Level Effects**

18 1. *Fisheries exploitation based on the $F_{40\%}$ strategy.*

19
20
21 The harvest strategy used in the BSAI and GOA has resulted in biomass reductions of Steller sea
22 lion prey species on the order of 40-60% from that of estimated unfished levels. After careful
23 consideration of the best available scientific and commercial data available, a link was
24 established in this effects section between this large-scale reduction in fish biomass and the
25 carrying capacity of Steller sea lions in the BSAI and GOA. It is NMFS opinion that these
26 biomass reductions of Steller sea lion prey species, along with other factors such as climate
27 change, natural predators, etc., were a significant contributing factor of the reduction and current
28 decline of the population of Steller sea lions.
29

30 Although the current strategy maintains biomass at acceptable levels for fisheries management,
31 the current harvest control rule in use by NMFS allows for significant variation below the target
32 biomass level. In essence, the fishery could be conducted to the point that only 2% of the
33 unfished biomass remained. Although this is an unlikely scenario, based on a precautionary ESA
34 strategy, variability below a threshold fished biomass should be limited to the extent practicable.
35 As far as the level of effect that constitutes a “take” of Steller sea lions, based on concerns of
36 their ability to forage effectively without reducing appreciable their likelihood of survival and
37 recovery, take could be expected to occur whenever the biomass of pollock, Pacific cod, or Atka
38 mackerel is below $B_{40\%}$. [Refer to Section 9.2.1]
39

40 **Regional Level Effects**

41 2. *Disturbance: Fishing and vessel traffic around Steller sea lion rookeries and haulouts.*

42
43
44 Traffic by federally permitted vessels, and the resulting disturbance to Steller sea lions, within 3
45 nm miles of rookeries and haulouts adversely affects them and results in “take” of Steller sea
46 lions because of harassment. Fishing activity for pollock, Pacific cod, and Atka mackerel within
47 20 nm of rookeries and haulouts effects and also results in “take” of Steller sea lions due to
48 competition for prey resources.
49

1 Previous measures in biological opinions on these fisheries to reduce impacts on Steller sea lions
2 did not consider all the groundfish fisheries in the scope of the action, which differs from the
3 scope of this opinion. These measures make good biological sense but need to be expanded
4 based on the foregoing effects analysis. Establishing additional 3 nm no-transit zones for
5 federally permitted vessels around Steller sea lion haulouts in the BSAI and GOA and closing all
6 rookeries and haulouts to 20 nm to directed fishing for pollock, Pacific cod, and Atka mackerel
7 would minimize the “take” resulting from competition for prey. Further, closing portions of the
8 critical habitat foraging areas would also be closed to directed fishing for the three species. This
9 would considerably reduce the amount of “take” (effects) resulting from this action. [Refer to
10 Section 9.2.2]

11
12 3. *Temporal concentration of fishing effort for pollock, Pacific cod, and Atka mackerel on a*
13 *seasonal time scale.*

14
15 Based on the best available scientific and commercial data, this effects section has discussed
16 temporal concentration of fisheries for pollock, Pacific cod, and Atka mackerel that result in high
17 local harvest rates (i.e. localized prey depletions) which would reduce the quality of the habitat
18 for Steller sea lions on a seasonal time scale. For example, fishing the entire TAC during the
19 winter season, which is believed to be a biologically stressful time for juveniles, would result in
20 an unacceptable level of “take” of those animals. Consequently, establishing summer and winter
21 seasons for all these species would be important to preventing localized depletion. “Take” is still
22 likely to occur as some Steller sea lions would be foraging in areas and times that the fishery
23 operates, however, this “take” could be set to a level that would not compromise the life of
24 individual Steller sea lions, their fecundity (breeding), or the population number when combined
25 with other measures. [Refer to Section 9.2.3]

26
27 4. *Spatial concentration of fishing effort for pollock, Pacific cod, and Atka mackerel.*

28
29 The effects section included analysis of the best available scientific and commercial data,
30 indicating that the spatial concentration of fisheries for pollock, Pacific cod, and Atka mackerel
31 results in high local harvest rates. This reduces the quality of habitat for foraging Steller sea
32 lions on a geographic scale. “Take” results from the inability of Steller sea lions to find
33 appropriate habitat in which to forage and survive due to the modification of that habitat by these
34 fisheries. Fishing can cause localized depletion of prey in a spatial context, making it more
35 difficult for sea lions to forage successfully. As noted in Chapter 4, sea lions rely on certain prey
36 densities to forage effectively.

37
38 Apportioning the annual harvest amount (TAC) to management areas and establishing harvest
39 limits for critical habitat (i.e. open areas only) based upon the ratio of the biomass in that
40 specific area compared to the total biomass (BSAI or GOA) would help minimize this effect.
41 [Refer to Section 9.2.3]

42
43 **6.6.4 Large cetaceans**

44
45 Measuring the potential effects of the groundfish fisheries on the marine ecosystem of the action area is
46 extremely difficult and realistically cannot be achieved with the available information. We cannot
47 dismiss any effects that might have occurred in the past and may continue to occur. Based on the
48 information available, it is also reasonable to consider that the groundfish fisheries and non-human
49 members of the marine ecosystem may compete with listed whales for a limited resource. However, the

1 direct or indirect effects of commercial fisheries in the BSAI and GOA, based on the limited information
2 available on the status, trends, distribution, and abundance of endangered whale species in the action area
3 and interactions between these whales and commercial fisheries, does not appear to be significant.
4 Although we do not have the information that would be necessary to determine how endangered whales
5 in the action area would be affected by cascade effects of these groundfish fisheries or competition, we
6 do know that recent information on humpback [the species most likely to compete with fisheries given
7 their dietary preferences and distribution], blue and bowhead whales suggest that these species are
8 increasing and do not appear to be experiencing these effects to a level that would inhibit recovery or
9 survival.

10 11 **6.6.5 Pacific salmon**

12
13 No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. The
14 ESA listed species or evolutionarily significant units (ESUs) that migrate into marine waters off Alaska,
15 originate in freshwater habitat in Washington, Oregon, Idaho, and California. In the marine waters off
16 Alaska, the ESA listed salmon stocks are mixed with hundreds to thousands of other stocks originating
17 from the Columbia River, British Columbia, Alaska, and Asia. The ESA listed fish are not visually
18 distinguishable from the other, unlisted, stocks. Mortal take of them in the salmon bycatch portion of the
19 fisheries is assumed based on limited abundance, timing, and migration pattern information gleaned from
20 recovery locations of coded-wire-tagged surrogate stocks.

21
22 The effects of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish
23 fisheries on listed salmon were considered through informal consultations with NMFS, Northwest
24 Region for fishing years 1992 and 1993 (February 20, 1992, April 21, 1993 respectively). Subsequent
25 informal consultation occurred for BSAI Amendment 28 (June 7, 1993), and for GOA Amendment 31
26 (September 22, 1993). NMFS stated in the latter two memoranda associated with the informal
27 consultation that it was essential that monitoring efforts be continued and that NMFS continue to seek
28 additional information regarding potential impacts to listed fish. In a biological opinion issued the
29 following year, NMFS stated that it believed that the potential effects of the GOA and BSAI groundfish
30 fisheries on listed salmon warranted formal ESA section 7 consultation (NMFS 1994).

31
32 The 1994 Biological Opinion was written to determine if continuation of the groundfish fisheries in the
33 BSAI and GOA, in 1994 and beyond, was likely to jeopardize the continued existence of Snake River
34 sockeye salmon, Snake River spring/summer chinook salmon or Snake River fall chinook salmon or
35 destroy or adversely modify critical habitat designated for these species. The biological opinion
36 established specific approaches that were used to assess the effects of the proposed action on listed
37 species. Effects are expressed in terms of numerical catch assessment, base period analysis, cumulative
38 effects analysis, and combined effects analysis.

39
40 After reviewing the current status, trends, distribution, and abundance of Snake River fall chinook, Snake
41 River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper
42 Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper
43 Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and
44 Snake River Basin steelhead, in the action area, interactions between these species and the BSAI and
45 GOA groundfish fisheries do not appear to be significant.

46 47 **6.6.6 Leatherback Turtles**

48
49 Leatherback turtles are extralimital within the Action Area. They do occur, generally as stranded animals

1 along the coastlines of southeast Alaska. However they are not considered to be abundant in the areas of
2 the greatest level of commercial fishing of the GOA, and not considered to be found in the BSAI at all.
3 To our knowledge there have been no takes of leatherbacks in the commercial fisheries in the BSAI and
4 GOA. Therefore we believe the direct and indirect effects of commercial fisheries in the BSAI and GOA
5 on this species is negligible and not likely to jeopardize its survival or recovery. We do not have the
6 information that would be necessary to determine how leatherback turtles in the action area would be
7 affected by cascade effects of these groundfish fisheries or competition. However, we know that this
8 species feeds entirely on salps and jellyfish and therefore would likely benefit from any cascade effects
9 that would filter down to the trophic level at which they forage. There is no fishery that is targeting the
10 prey of this species.

7 CUMULATIVE EFFECTS

Cumulative effects include the effects of *future* State, tribal, local, or private actions that are reasonably certain to occur in the action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Past and present impacts of non-federal actions are part of the environmental baseline discussed in section 5. The following discussion will focus on just those actions that may adversely affect listed species.

7.1 Direct Effects

Perhaps the most obvious effect on listed species would be direct take. For Steller sea lions, there is a direct take in the subsistence harvest by Alaska Natives which is expected to continue into the foreseeable future. The number of sea lions harvested has declined in the past few years to somewhere around 180 animals per year. It is not clear if the decline will continue. The majority of sea lions are taken by Aleut hunters in the Aleutian and Pribilof Islands. The great majority (99%) of the statewide subsistence take was from west of 144°W long. (i.e., the range of the western population). The overall impact of the subsistence harvest on the western population will be determined by the number of animals taken, their sex and age class, and the location where they are taken. As is the case for other sources of mortality, the significance of subsistence harvesting may increase as the western population decreases in size unless the harvesting rate is reduced accordingly. However, the subsistence harvest accounts for only a relatively small portion of the animals currently lost to the population each year as described in section 5.2.2.

7.2 Indirect Effects

7.2.1 Alaska State commercial fisheries

Commercial groundfish fisheries that are managed by the State of Alaska were introduced in the *Environmental Baseline* chapter of this biological opinion. We expect those fisheries to continue into the future, with some increases if the State of Alaska develops a small boat fleet. Nevertheless, the size of the State groundfish fisheries are generally small when compared to the federal groundfish fisheries and are expected to have less impacts on listed species with respect to competition for prey and long term ecosystem impacts. The crab fishery is one of the biggest fisheries managed by the state, which is not likely to directly compete for prey with either Steller sea lions or other listed species.

Herring, salmon, Pacific cod, pollock, squid, and octopus are items found year-round in the diet of Steller sea lions. For species such as salmon and herring, they occur much more frequently in the summer as determined by analyses of scat samples from 1990-1998 (see figs 4.5 and 4.6 showing prey in scat samples). Biomass assessments and trends, stock recruitment, and escapement estimates for many of these stocks is often based on visual interpretation, escapement counts, or estimates of egg production. Reliable stock information for most of these fisheries is not available.

Perhaps the most important interaction between state fisheries and listed species may arise from the intense pattern of localized removals of spawners. Although the patterns are generally similar from one fishery to the next, the sheer number of distinct fisheries makes it difficult to describe them individually.

1 Likewise, each fishery is distinctly different in the number of boats, gear used, time of year, length of
2 season, and fish species. Therefore, we will present a few examples to demonstrate some of the
3 competitive interactions which may occur.
4

5 We have direct evidence that Alaska's herring fisheries, in particular, compete with Steller sea lions and
6 other listed species. Steller sea lions appear to be attracted to the dense aggregations of herring that occur
7 along some sections of the coast during the herring's short, spawning period. Because the timing of
8 herring spawning varies, fishery managers have learned to depend on the presence of Steller sea lions to
9 determine when herring spawning is imminent. Managers generally begin flying aerial surveys over
10 potential herring spawning grounds well in advance of expected herring spawning events (for several
11 weeks prior to spawning, herring are usually present near their spawning grounds, but they are too deep
12 in the water column to be seen from aircraft). When these aerial surveys observe Steller sea lions and
13 cetaceans on the spawning grounds, they interpret those observations as indicating the presence and
14 impending spawning of herring (fishery managers usually note the presence of Steller sea lions in their
15 field notebooks, occasionally recording actual counts).
16

17 Several days before spawning, herring move into shallower water and become directly detectable by
18 aerial surveys. Under the direction of these aircraft, the fishing fleet moves into the general area where
19 the fishery will take place. Steller sea lions have been observed in the middle of these fishing areas and
20 have been observed leaving the spawning grounds shortly after the herring finish spawning (fishery
21 biologists survey the biomass of the spawning deposits by SCUBA, but wait until the sea lions leave the
22 area for safety reasons).
23

24 One example of a herring spawning event where Steller sea lion counts were quantified during aerial
25 surveys is shown in Figure 5.10. Steller sea lions were already in the area at the time of the first ADFG
26 aerial survey on April 19, diving on the deeply submerged herring schools, as were a number of
27 humpback whales. Following the spawning event, large numbers of birds appeared on the beaches to
28 feed on the herring eggs, noted in numbers of 11,000 to 20,000. Approximately 150 Steller sea lions
29 were counted in the area. Similar descriptions of humpback whale and Steller sea lion presence on
30 herring spawning grounds are available in field notes from other herring fishing areas (there was no
31 fishery at Hobart Bay in the spring of 2000 because the quota had been taken in the earlier food/bait
32 herring fishery).
33

34 The impacts of some of the State fisheries on Steller sea lions and, in some cases, humpback whales
35 would be similar to those of the Federal fisheries: cascade effects and competition. Steller sea lions and
36 some of the State fisheries actively demand a common resource and the fisheries reduce the availability
37 of that common resources to Steller sea lions while they satisfy their demand for fish. The State
38 groundfish fisheries reduce the abundance or alter the distribution of several prey species that include
39 walleye pollock and cod. The groundfish fisheries can cause dense schools of prey species to scatter
40 which affects the foraging behavior of marine mammals and seabirds that target aggregated prey (Brock
41 and Riffenburgh 1960, Dayton et al. 1995, and others). Repeatedly causing fish schools to scatter and
42 reducing their density would also reduce the value of the foraging areas to Steller sea lions by increasing
43 the amount of time and energy and sea lion would have to expend to feed on the same number of fish.
44 The reductions of biomass at larger spatial scales would exacerbate the effects of small-scale depletions
45 caused by fishing; because the spawning biomass in the entire ecosystem is about half of what it would
46 be without fishing, there are fewer spawning-aged fish to replenish areas where fishing has occurred.
47

48 Based on available data, we would expect several State groundfish fisheries, particularly the pollock and
49 cod fisheries, to compete with foraging Steller sea lions, substantially contribute to their nutritional

1 stress, and appreciably reduce the value of the marine portions of critical habitat that has been designated
2 for Steller sea lions. The fisheries may reduce the abundance of prey within these marine, foraging areas
3 and would alter the distribution of groundfish prey in ways that would reduce the effectiveness of
4 foraging sea lions. The reduction in the abundance of prey species and the alteration of their distribution
5 could effectively keep the carrying capacity of critical habitat for Steller sea lions below the current
6 population size.

7 8 **7.2.2 Alaska State sport fisheries**

9
10 Meeting public demand for recreational fishing opportunities in Alaska while at the same time
11 maintaining and protecting the fisheries resources has become a significant challenge for ADFG (Howe
12 et al. 1996 “harvest, catch, and participation in Alaska sport fisheries during 1995”). Today, along with
13 increasing tourism and continued population growth, there is increased pressure on sport fisheries,
14 development of new fisheries, and increased crowds. At the core of sport fisheries management is the
15 ADFG onsite “creel” surveys. ADFG staff survey fisherman as they return to the docks, requesting
16 information on catch and time fished, as well as collecting biological samples, fish tags and other
17 information. Additionally, the department conducts surveys through the mail requesting further
18 information from fisherman on the annual harvest. This information is compiled and published in annual
19 sport fishery reports (Howe et al. 1999).

20
21 Of the 469,436 anglers who fished in Alaska in 1995, about 51% were Alaska residents and 49% were
22 nonresidents, and resulted in about 3 million angler-days fished. This resulted in 2,909,979 fish
23 harvested which included 1,299,945 razor clams (*Siliqua patula*) and 52,905 smelt and capelin
24 (*Osmeridae*). Of the remaining 1,657,129 harvested fish, 55% were salmon, 20% were halibut, 7% were
25 rainbow trout, 5% were rockfish, 4% were Dolly Varden and Arctic char, 3% were grayling, and 1%
26 were landlocked salmon. Also harvested, at much lower rates, were lingcod, whitefish, steelhead, and
27 sheefish. Since 1985, the number of anglers fishing in Alaska has increased 35%, about 3% per year.
28 Trends in annual catch rates are most affected by fluctuations in salmon abundance, species such as
29 halibut and rockfish as been more consistent over the last 20 years (Howe et al., 1996).

30
31 For perspective, the sport fishery harvests about 1% (4,000 mt) of the annual State of Alaska total fish
32 harvests, while the commercial fisheries accounted for 97% (900,000 mt) of the annual harvest in 1998,
33 and would be expected to continue in relatively low amounts in the future. It is likely that increased
34 levels of tourism will also increase the actual amount of fish taken for sport. However, this additional
35 harvest would likely result in a comparatively small amount of fish taken. Plus, the nature of most of the
36 fisheries is slow removal rates and dispersed catch. The most concentrated catches are in the salmon
37 fisheries, however, many of these such as the Kenai fisheries, actually take place upriver outside of
38 foraging areas of listed species considered here.

39 40 **7.2.3 Alaska State subsistence harvest of groundfish in the GOA and BSAI**

41
42 Subsistence hunting and fishing are important to the economies of many families and communities in
43 Alaska. Furthermore, subsistence uses are central to the customs and traditions of many cultural groups
44 in Alaska, including the Aleut, Athabaskan, Alutiiq, Euroamerican, Haida, Inupiat, Tlingit, Tsimshian,
45 and Yup'ik. We can conclude that this traditional way of securing necessary resources will continue for
46 these rural communities in Alaska. About 20% of Alaska's population (124,367 people in 270
47 communities in 1998) participates in the subsistence harvest. Most of the harvest is composed of fish
48 (about 60% by weight) and by marine mammals (14% by weight; see direct take of Steller sea lions by
49 the subsistence fishery in section 7.1). For perspective, the subsistence fishery harvests about 2% (8,000

1 mt) of the annual State of Alaska total fish harvests, while the commercial fisheries account for 97%
2 (900,000 mt) of the annual harvest in 1998. Consequently, although subsistence harvests are likely to
3 continue into the future, and possibly grow if population increases, the amount taken for consumptive
4 uses is very small compared to the commercial catch of fishery resources which is largely transported
5 outside of the state (ADFG 1998 "Subsistence in Alaska: 1998 Update").
6

7 **7.2.4 Alaska State oil and gas leasing**

8
9 In 1896, oil claims were staked at Katalla approximately 50 miles south of Cordova. Oil was discovered
10 there in 1902. An on-site refinery near Controller Bay produced oil for over thirty years. The refinery
11 burned down in 1933 and was not replaced. Exploration in Cook Inlet began in 1955 on the Kenai
12 Peninsula in the Swanson River area, and oil was discovered in 1957 which sparked an oil rush in
13 southcentral Alaska. Today, a number of active fields produce oil in Cook Inlet, all of which is
14 processed at the refinery at Nikiski on the Kenai Peninsula (Department of Natural Resources 2000).
15 Estimated oil reserves in Cook Inlet are 72 million barrels of oil. Currently there are additional lease
16 sales planned through 2005 for the Cook Inlet area, but none for areas outside of Cook Inlet which would
17 fall within the action area.
18

19 **7.2.5 Alaska State population**

20
21 The effects of the human population in Alaska, past and present, was discussed in section 5.2.1. Alaska
22 has the lowest population density of all of the states in the United States. Although Alaska's population
23 has increased by almost 50 percent in the past 20 years, most of that increase has occurred in the Cities of
24 Anchorage and Fairbanks. Outside of Anchorage, the largest populations occur on the Kenai Peninsula,
25 the Island of Kodiak, Bethel, and in the Valdez - Cordova region. Outside of the City of Anchorage, few
26 of the cities, towns, and villages would be considered urbanized. It is probable that the population in
27 Alaska will continue to expand at a high rate, especially in urban areas. Rural areas may increase or
28 decrease based on their ability to exploit resources such as fisheries, and secure their necessities to live in
29 these remote areas. Many rural villages have experienced population declines, most of them in the
30 Aleutians. To bolster these communities, the state has begun to develop local fisheries. For example, the
31 state would to see the development of a community in Adak, to help accomplish this the state has
32 implemented a local Adak Pacific cod fishery where vessels fishing under the federal TAC would be
33 excluded by size in order to allow the local small boat fleet to harvest the TAC in that area. This
34 effectively takes management control away from the federal government, concentrates catch inside of
35 state waters (out to 3 miles), and focuses the dependance of specific coastal communities on a resource
36 which may not be available in the future. This system may put severe pressure on fishery managers in
37 the future to enact regulations which provide for near-shore fisheries. However, this may directly
38 conflict with measures to limit adverse impacts to critical habitat.
39

40 In general, as the size of human communities increase, there is an accompanying increase in habitat
41 alterations for housing, roads, commercial facilities, and other infrastructure. The impact of these
42 activities on pristine landscapes and the biota they support increases as the size of the human population
43 expands. As terrestrial plant communities and coastal areas are destroyed, modified, or fragmented for
44 the construction of human communities, native plants and animals are displaced, and can become locally
45 extinct. A detailed description of these effects on water quality is found in section 5.2.1, and is not
46 expected to be more significant in the future given current and expected levels of federal and state
47 regulation for waste disposal and management.
48

49 As the human population expands (as is expected mostly around the major cities), the risk of disturbance

1 also increases. Several studies have noted the potential adverse effects of human disturbance on Steller
2 sea lions. Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely
3 variable effects on hauled-out sea lions. Sea lion reaction to occasional disturbances ranges from no
4 reaction at all to complete and immediate departure from the haulout area. The type of reaction appears
5 to depend on a variety of factors. When sea lions are frightened off rookeries during the breeding and
6 pupping season, pups may be trampled or even abandoned in extreme cases. Sea lions have temporarily
7 abandoned some areas after repeated disturbance (Thorsteinson and Lensink 1962), but in other
8 situations they have continued using areas after repeated and severe harassment. Johnson *et al.* (1989)
9 evaluated the potential vulnerability of various Steller sea lion haulout sites and rookeries to noise and
10 disturbance and also noted a variable effect on sea lions. Kenyon (1962) noted permanent abandonment
11 of areas in the Pribilof Islands that were subjected to repeated disturbance. A major sea lion rookery at
12 Cape Sarichef was abandoned after the construction of a light house at that site, but then has been used
13 again as a haulout after the light house was no longer inhabited by humans. The consequences of such
14 disturbance to the overall population are difficult to measure. Future disturbance may contribute to or
15 exacerbate the decline. Disturbance may also effect listed whales, however little information exists to
16 determine whether whale watching tours, fishing boats, or traffic in general degrades the foraging
17 success of these animals or increases their stress level.

8 CONCLUSIONS

After reviewing the current status of endangered blue whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered blue whales.

After reviewing the current status of endangered bowhead whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered bowhead whales.

After reviewing the current status of endangered fin whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered fin whales.

After reviewing the current status of endangered humpback whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered humpback whales.

After reviewing the current status of endangered right whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered right whales.

After reviewing the current status of endangered sei whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered sei whales.

After reviewing the current status of endangered sperm whales, the environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued existence of endangered sperm whales.

After reviewing the current status of endangered western population of Steller sea lions, the environmental baseline for the action area, the Fishery Management Plans for Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the action, as proposed, is likely to jeopardize the continued existence of the western population of Steller sea lions.

After reviewing the current status of threatened eastern population of Steller sea lions, the environmental

1 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the
2 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
3 opinion that the fishery management plans are not likely to jeopardize the continued existence of
4 threatened eastern population of Steller sea lions.

5
6 After reviewing the current status of threatened Puget Sound chinook salmon, the environmental baseline
7 for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea
8 and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that
9 the fishery management plans are not likely to jeopardize the continued existence of Puget Sound
10 chinook salmon.

11
12 After reviewing the current status of threatened Lower Columbia River chinook salmon, the
13 environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska
14 Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is
15 NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued
16 existence of Lower Columbia River chinook salmon.

17
18 After reviewing the current status of endangered Upper Columbia River chinook salmon, the
19 environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska
20 Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is
21 NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued
22 existence of Upper Columbia River chinook salmon.

23
24 After reviewing the current status of threatened Upper Willamette River chinook salmon, the
25 environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska
26 Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is
27 NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued
28 existence of Upper Willamette River chinook salmon.

29
30 After reviewing the current status of threatened Snake River spring/summer chinook salmon, the
31 environmental baseline for the action area, the effects of the Fishery Management Plans for Alaska
32 Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is
33 NMFS' biological opinion that the fishery management plans are not likely to jeopardize the continued
34 existence of Snake River spring/summer chinook salmon.

35
36 After reviewing the current status of threatened Snake River fall chinook salmon, the environmental
37 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the
38 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
39 opinion that the fishery management plans are not likely to jeopardize the continued existence of Snake
40 River fall chinook salmon.

41
42 After reviewing the current status of threatened Snake River sockeye salmon, the environmental baseline
43 for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea
44 and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that
45 the fishery management plans are not likely to jeopardize the continued existence of Snake River sockeye
46 salmon.

47
48 After reviewing the current status of endangered Upper Columbia River steelhead, the environmental
49 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the

1 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
2 opinion that the fishery management plans are not likely to jeopardize the continued existence of Upper
3 Columbia River steelhead.
4

5 After reviewing the current status of threatened Middle Columbia River steelhead, the environmental
6 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the
7 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
8 opinion that the fishery management plans are not likely to jeopardize the continued existence of Middle
9 Columbia River steelhead.
10

11 After reviewing the current status of threatened Lower Columbia River steelhead, the environmental
12 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the
13 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
14 opinion that the fishery management plans are not likely to jeopardize the continued existence of Lower
15 Columbia River steelhead.
16

17 After reviewing the current status of threatened Upper Willamette River steelhead, the environmental
18 baseline for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the
19 Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological
20 opinion that the fishery management plans are not likely to jeopardize the continued existence of Upper
21 Willamette River steelhead.
22

23 After reviewing the current status of threatened Snake River Basin steelhead, the environmental baseline
24 for the action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea
25 and Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that
26 the fishery management plans are not likely to jeopardize the continued existence of Snake River Basin
27 steelhead.
28

29 After reviewing the current status of endangered leatherback turtle, the environmental baseline for the
30 action area, the effects of the Fishery Management Plans for Alaska Groundfish in the Bering Sea and
31 Aleutian Islands and Gulf of Alaska, and the cumulative effects, it is NMFS' biological opinion that the
32 fishery management plans are not likely to jeopardize the continued existence of leatherback turtles.
33

34 After reviewing the current status of critical habitat that has been designated for the western population
35 of Steller sea lions, the environmental baseline for the action area, the Fishery Management Plans for
36 Alaska Groundfish in the Bering Sea and Aleutian Islands and Gulf of Alaska, and the cumulative
37 effects, it is NMFS' biological opinion that the fishery management plans are likely to adversely modify
38 this designated critical habitat.

9 REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR §402.02) implementing section 7 of the ESA define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

Based on the synthesis discussion in Section 6 and conclusions in Section 8, a reasonable and prudent alternative (RPA) for the groundfish fisheries in the BSAI and GOA is required to avoid: (1) jeopardy to the western stock of Steller sea lions, and (2) adverse modification of their critical habitat. The fisheries effects that give rise to these determinations include both large scale removals of Steller sea lion forage over time, and reduced availability of prey on the fishing grounds at scales of importance to individual foraging Steller sea lions, particularly in critical habitat. This RPA also establishes a monitoring scheme to inform the management process about the nature of the Steller sea lion/fishery interaction while providing a mechanism by which management success can be measured.

Based on the effects discussion found in Section 6, and NMFS determination that fishing activity under the FMPs are likely to jeopardize the continued existence of the western population of Steller sea lions and are likely to adversely modify their designated critical habitat, NMFS has developed an RPA with multiple components for the groundfish fisheries in the BSAI and GOA. The fisheries effects that give rise to these determinations include both large scale removals of Steller sea lion forage over time, and the potential for reduced availability of prey on the fishing grounds at spatial and temporal scales of importance to individual foraging Steller sea lions.

9.1 Principles for the Reasonable and Prudent Alternative

This biological opinion includes one RPA alternative, which has multiple management measures or elements that are essential to avoid the likelihood of the groundfish fisheries jeopardizing the continued existence of the endangered western population of Steller sea lions or adversely modifying its designated critical habitat. Together these measures are designed to minimize adverse effects of removing prey biomass and avoid competition. The following is a summary of the general principles used to minimize competition between fisheries and Steller sea lions:

Global Control Rule

The current control rule used to determine the allowable biological catch (ABC) for pollock, Pacific cod, and Atka mackerel in the BSAI and GOA will be revised to take into account the prey requirements of Steller sea lions. This revision will result in a more conservative catch amount (i.e., reduced fishing mortality rate) when the spawning biomass is estimated to be less than 40% of the projected unfished biomass. There would be no directed fishing for a species when the spawning biomass is estimated to be less than 20% of the projected unfished biomass. Subsequent text will explain the scientific basis for these threshold levels.

1 **Fishing Closures to Eliminate Competition**
2

3 Approximately 66% of critical habitat would be closed to directed fisheries for pollock, Pacific
4 cod, and Atka mackerel, eliminating the possibility for competition in these areas . A description
5 of the closed areas can be found in Table 9.1.
6

7 Closed areas can be divided into three types. The first form will be a continuation of the current
8 3 nm no-entry zones around rookeries. The second form of closed area is comprised of 3 nm no-
9 fishing zones (for all federally permitted vessels) around all major haulouts that have been
10 previously identified as either part of designated critical habitat or in the RFRPAs contained in
11 biological opinions for the pollock fishery. The third form of closed area is a partial closure to
12 directed fishing for pollock, Pacific cod, and Atka mackerel inside certain expanded habitat
13 zones. These zones consist of critical habitat areas and additional Steller sea lion protection
14 areas identified in previous biological opinions and will be referred to in this document as CH-
15 RFRPA sites, i.e. those sites listed as critical habitat and the additional important haulouts
16 identified in the RFRPAs.
17

18 **Spatial Distribution**
19

20 Seasonal harvest limits for pollock, Atka mackerel, and Pacific cod will be established for those
21 areas of critical habitat open for fishing, based on the projected biomass in that geographic area
22 by season. Any TAC amount available inside critical habitat can be taken outside of critical
23 habitat during the concurrent season outside.
24

25 **Temporal Distribution**
26

27 Fishing for pollock, Pacific cod and Atka mackerel will be prohibited from November 1 through
28 January 20 inside critical habitat. Additionally, fishing for these species with trawl gear will be
29 prohibited in all areas from November 1 through January 20.
30

31 Inside critical habitat, NMFS will establish 4 equally spaced seasons for all 3 fisheries in the
32 CH-RFRPA open zones to further ensure against high removal rates and possible localized
33 depletions of prey in the most important area for Steller sea lions. This measure will evenly
34 divide the combined winter allocation of 40% to the A and B seasons, and the combined fall
35 allocation of 60% to the C and D seasons based on projected biomass in that geographic area by
36 season. Any amount available in a CH-RFRPA zone may be taken outside of that area during the
37 same season. For example, the critical habitat harvest limit specified for the ‘B’ season could be
38 taken outside critical habitat anytime within the A/B season.
39

40 Outside of critical habitat, NMFS will establish 2 evenly spaced seasons for all 3 fisheries in the
41 EBS, GOA, and AI (40% of the annual TAC in the A/B season, and 60% of the annual TAC in
42 the C/D season).
43

44 **9.2 Reasonable and Prudent Alternative**
45

46 Before prosecuting groundfish fisheries in 2001, NMFS shall amend the FMPs for groundfish in the
47 BSAI and GOA to include the following RPA which consists of 5 general measures, some of which
48 contain sub-elements. NMFS may effect this amendment by working through the NPFMC, through
49 emergency regulations, or through other action taken by the Secretary of Commerce.

9.2.1 Global Control Rule

NMFS will augment the current harvest control rule for determining ABCs with the one provided in this RPA. This change provides additional protection for Steller sea lions.

This rule will apply only to fishing mortality rates established for pollock, Pacific cod, and Atka mackerel in the GOA, AI, and EBS Bering Sea. The ABCs for pollock, Pacific cod, and Atka mackerel will continue to be determined using the best available scientific methods that involve using single, or if available, multi-species models. This measure changes current practice by adjusting the $F_{40\%}$ and F_{OFL} rates if the spawning biomass (B) is projected to be below 40% of the unfished biomass ($B_{40\%}$) in the following year. It would apply to stocks in this range are in Tier 3b. Currently, adjustments to $F_{40\%}$ and F_{OFL} rates for stocks in Tier 3b are made using the following equations, where $\alpha=0.05$:

$$F_{OFL} = F_{30\%} \times (B/B_{40\%} - \alpha)/(1-\alpha)$$
$$F_{40\% \text{ (adjusted)}} = F_{40\%} \times (B/B_{40\%} - \alpha)/(1-\alpha)$$

Under this current control rule, the reduction in F below $F_{40\%}$ is linear depending on how far the stock is below $B_{40\%}$. Using an $\alpha=0.05$ means that fishing mortality rates are 0, i.e., no fishing, when the stock reaches 5% of $B_{40\%}$, or 2% of its equilibrium unfished level.

Under the control rule contained in the RPA, α will be increased from 0.05 to 0.5 for the pollock, Atka mackerel, and Pacific cod fisheries in the EBS, GOA, and AI. When the spawning biomass falls below 40% of the unfished biomass ($B < B_{40\%}$) for any of these stocks, F will decline faster under this control rule than under the existing management regime to buffer the effects of natural variability in stock abundance. Furthermore, directed fishing for pollock, Pacific cod and Atka mackerel would cease if their spawning biomass fell to 20% or below of equilibrium unfished levels, or 50% of $B_{40\%}$. Consequently, fishing for pollock, Pacific cod and Atka mackerel under this control rule would cease at a population size 10 times larger than under current practices. This measure should ensure that adequate levels of each prey species are maintained for Steller sea lions.

9.2.2 Closure areas

NMFS will create closure areas. The first form of closure areas will be a continuation of the current 3 nm no-entry zones around rookeries specified as critical habitat in 50 CFR part 223. The second form of closures will be comprised of 3 nm no fishing zones for all federally permitted groundfish fishery vessels around major haulouts identified as critical habitat in 50 CFR part 226 or identified as important to the foraging needs of Steller sea lions in the 1998 Biological Opinion for the BSAI and GOA and in the RFRPAs for the pollock fishery. The areas identified as important to the foraging needs of Steller Sea lions were determined from information gathered during surveys since 1979 and included the following criteria: (1) summer haulouts with more than 200 sea lions in a summer survey, and less than 75 sea lions in winter surveys (Summer haulouts); (2) winter haulouts with less than 200 sea lions in summer surveys, and greater than 75 sea lions in a winter survey (Winter haulouts); and (3) year-round haulouts with more than 200 sea lions in a summer survey, and 75 sea lions in a winter survey. These two forms of closure areas are provided with the greatest protection, consistent with the hierarchy of protection established in this, as well as previous, biological opinions, and the importance of areas around rookeries and haulouts to the foraging needs of Steller sea lions.

The third form of closure is a system of closed CH-RFRPA zones which eliminates the possibility for competition between pollock, Pacific cod, and Atka mackerel fisheries and Steller sea lions within those

1 areas.

- 2
- 3 4. Areas around all rookeries and haulouts sites out to 20 nm that are listed in 50 CFR part
- 4 226 as critical habitat.
- 5
- 6 5. Areas around haulout sites out to 20 nm, as identified in the 1998 Biological Opinion for
- 7 the BSAI and GOA pollock fishery
- 8
- 9 3. Critical habitat pelagic foraging areas of the Shelikof Strait in the GOA, Seguam Pass in
- 10 the AI, and the Sea Lion Conservation Area (SCA). The SCA is located in the EBS and
- 11 is an expansion of the Bogoslof Foraging Area to include specified areas outside of
- 12 critical habitat specified at 50 CFR part 226. The inclusion of areas outside of
- 13 designated critical habitat prevents the potential for edge-effect depletions caused by
- 14 concentrated fishing in small open areas bounded by critical habitat.
- 15

16 The entire area included within the CH-RFRPA zone will then be subdivided into 13 management zones.

17 Some of these zones will be closed to all fishing for pollock, Pacific cod, and Atka mackerel, while other

18 areas will be open for fishing provided that additional temporal measures are implemented to minimize

19 competition with Steller sea lions. These zones are further described in Tables 9.1 and 9.2. In all,

20 approximately 66% of the total area described below will be closed year-round to directed fishing for

21 pollock, Pacific cod, and Atka mackerel.

22

23 **9.2.3 Temporal apportionment of TACs**

24

25 Fishing for pollock, Pacific cod and Atka mackerel inside critical habitat will be prohibited from

26 November 1 through January 20. Additionally, the current trawl closure from November 1 through

27 January 20 will be continued for all areas. Outside of critical habitat, NMFS will establish 2 evenly

28 spaced seasons for all 3 fisheries in the EBS, GOA, and AI. An amount of the annual TAC would be

29 apportioned to each season based on the approach used in the 1998 Biological Opinion so that 40% of the

30 annual TAC is available in the winter season (A/B seasons) and 60% would be available in the fall

31 season (C/D seasons). Inside critical habitat, four seasons will be established for the open CH-RFRPA

32 zones to ensure against high removal rates and possible localized depletions of prey in the most important

33 area for Steller sea lions. This measure will evenly subdivide the combined winter allocation of 40% to

34 the A and B seasons (20% each to the A and B season inside CH), and the combined fall allocation of

35 60% to the C and D seasons (30% each to the C and D season inside CH). This inside critical habitat

36 percentage (critical habitat was used as a proxy for the entire CH-RFRPA area) would then be multiplied

37 by the ratio of biomass inside to biomass outside of the critical habitat area to derive the seasonal

38 apportionment (this is discussed further below).

39

40 **9.2.4 Spatial apportionment of TAC**

41

42 The annual TACs will be apportioned to NMFS management areas according to the status-quo method

43 based on estimates of the seasonal distribution of biomass. Additionally, a harvest limit would be

44 imposed on fishing in the combined CH-RFRPA area based on the proportion of biomass estimated to be

45 in critical habitat open to fishing to the total biomass in the overall management area (NMFS 2000). This

46 methodology ensures that the harvest rate in critical habitat will not be greater than the global rate as

47 determined by the global control rule.

48

49 The determination of the fraction of biomass inside critical habitat should be based on the best available

1 information for the distribution of pollock, Pacific cod, and Atka mackerel. We have determined the
2 proportion of TAC to assign to the open portions of critical habitat by using average (1998-99) catch in
3 open areas as a percentage of all the combined zones (1-13) by species, season and management area
4 (NMFS 2000). We assume that the catch distribution in 1998-99 best reflects the biomass distribution.
5 We recognize that this method would be best replaced by a comprehensive survey program that
6 performed surveys and estimated biomass in the winter as well as summer for all 3 species.
7

8 Further, a portion of the AI will be opened to pollock fishing that was previously closed under earlier
9 biological opinions and the Pacific cod TAC will be split from a combined BSAI TAC to separate TACs
10 for the EBS and the AI based on the distribution of the stock.
11

12 **9.2.5 Monitoring**

13

14 The action area described in Section 3 was divided into three primary blocks, referred to as blocks I, II,
15 and III (see Fig. 9.1). Each of these blocks was further subdivided into 13 areas of the expanded critical
16 habitat areas referred to as the CH-RFRPA (Tables 9.1 and 9.2). The following objectives were used in
17 defining the 13 areas: (1) at least 50% of critical habitat should be closed to fishing ,(2) the area closed to
18 fishing should protect approximately 50% of the non-pup population and 75% of the areas where pups
19 are born, (3) the underlying trend in open and closed areas in each of the three blocks should be
20 statistically equivalent to allow for independent evaluation of the efficacy of the RPA in the three blocks,
21 and (4) after a period no-longer than six years of monitoring, there should be an acceptable likelihood of
22 successfully detecting an improvement in the status of Steller sea lions in each of the three blocks. The
23 details of the design area are provided in section 9.5.
24

1 **9.2.6 Overview of the conservation impacts of the RPA**

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The following is a list of the management actions required under the RPA, for the GOA, EBS and AI and the impact of those actions in terms of Steller sea lions protected, portions of critical habitat and important foraging areas closed to pollock, Pacific cod and Atka mackerel fishing, resultant TAC reductions, and seasonal releases:

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1. Increase the Protection on Sea Lion Forage Base	
Management Action	Conservation Impacts of the Action
Modify the control rule for the overall fishery harvest of the three primary prey species to rapidly reduce the harvest rate should any stock fall below the target reference level. Close the directed fishery on any stock at 20% of its unfished biomass.	<ul style="list-style-type: none">* Rapidly reduces the impact of the fishery on the forage base for sea lions even if the reduction in prey species is due to non-fishing factors (i.e., environmental variability).* Reduces the maximum ABC for GOA pollock by 19,000 mt in 2001.* Reduces the maximum ABC for EBS cod by 8,800 mt in 2001.*Reduces the maximum ABC for AI Pacific cod by 1,100 mt in 2001.

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2. Increase the Protection for Critical Habitat Areas Through the Use of Closures	
Management Actions	Conservation Impacts of the Actions
Create 3 nm no-fishing zones around 78 rookeries and haulouts in the GOA, 11 in the EBS and 50 in the AI.	* Protects all pups and non-pups in the GOA, the EBS, and the AI from fishing effects and disturbance out to 3 nm from rookeries and haulouts.
Pollock and Pacific cod fishery exclusion zones in 80,926 km ² (56% of 144,511 km ²) of the critical habitat area in the GOA.	* Further protects 4,068 pups and 9,016 non-pups in the GOA, 411 pups and 1,508 non-pups in the EBS, and 2,425 pups and 3,588 non-pups in the AI from fishing effects and disturbance 3-20 nm from rookeries and haulouts in closed critical habitat.
Pollock, Pacific cod and Atka mackerel fishery exclusion zones in 91,844 km ² (82% of 112,005 km ²) of the critical habitat area in the EBS.	* Closes areas where approximately 16% of GOA pollock and 28% of GOA Pacific cod catches, 23% of EBS pollock, 24% of EBS Pacific cod, and 2% of BSAI Atka mackerel, 53% of AI pollock, 21% of AI Pacific cod, and 44% of BSAI Atka mackerel catches have occurred (1998-99) .
Pollock, Pacific cod, and Atka mackerel fishery exclusion zones in 62,570 km ² (63% of 99,318 km ²) of the critical habitat area in the AI.	* Greatly reduces the interactions between fisheries and sea lions from November 1 to January 20 (22% of the year).
No fishing in critical habitat for Pollock and Atka mackerel, and Pacific cod from November 1 to January 20, and no trawling for those species during this period anywhere.	

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3. Increase the Temporal Dispersion of the Catch to Minimize the Risk of Localized Depletion of Prey Species	
Management Actions	Conservation Impacts of the Actions
<p>The remaining fishing in critical habitat areas is divided into four seasons beginning January 20, April 1, June 11, and August 22.</p> <p>The seasonal harvest limits in critical habitat are roughly evenly distributed throughout the year and are proportional to biomass distribution.</p> <p>Outside of critical habitat, fishing is apportioned into two seasons, beginning January 20 and June 11, with 40% and 60% of the available ABC allocated respectively.</p>	<p>* Reduction in the proportion of Pacific cod taken during the winter in the GOA from 58% to 40%, in the EBS from 52% to 40% and in the AI from 64% to 40% compared to 1998.</p> <p>* Reduction in the proportion of the Atka mackerel catch taken in winter in the AI from 54% to 40% compared to 1998.</p> <p>* Protect against excessive harvest rates which may rapidly deplete concentrations of prey in and near critical habitat.</p>
4. Spatial Distribution and Further Reduction of the Harvest of the Three Primary Prey Species Within Critical Habitat	
Management Action	Conservation Impacts of the Action
<p>The allocation of ABC to the remaining open area inside critical habitat and outside critical habitat is based on the best available information on the biomass distribution between these areas.</p>	<p>* Reduction in percentage of pollock caught in critical habitat from 80% to 42% in the GOA, from 45% to 14% in the EBS, and from 74% to 2% compared to 1998.</p> <p>* Reduction in percentage of Pacific cod caught in critical habitat from 48% to 21% in the GOA, 39% to 17% in the EBS and 79% to 17% in the AI compared to 1998.</p> <p>* Reduction in percentage of Atka mackerel caught in critical habitat from 66% to 8% in the AI compared to 1998.</p>
5. Provide a Basis for Developing Better Information on the Impacts of Area Closures and Other Measures	
Management Action	Conservation Impacts of the Action
<p>Select area closures to provide contrast between complete closures and restricting fishing areas within critical habitat.</p>	<p>*Provide a stronger experimental statistical basis for the evaluation of area closures on sea lion recovery.</p> <p>*Provide a stronger monitoring capability through experimental design.</p>

1 **9.3 Implementation of the RPA**

2
3 This section outlines the specific elements of the RPA that must be implemented as described here and
4 identify those items that are frameworked. The FMP level aspect of this RPA, the global control rule,
5 was described in section 9.2.1 and will not be further discussed here. Therefore, this section outlines the
6 methods of implementing the project level aspects of the RPA in further detail than were described in
7 sections 9.2.2 through 9.2.6.

8
9 The following table is a brief overview of the temporal fishing pattern required by the RPA. Season
10 dates and percentage of the annual TAC apportioned to each season are fixed. However the catch limit in
11 critical habitat will be a frameworked RPA so that the appropriate limit can be estimated on an annual
12 basis during the Council’s TAC specification process. This allows the incorporation of the most recent
13 survey biomass estimates. The details of how these TAC apportionments will be determined follows for
14 each individual species below.

15

	Seasons			
Area	A	B	C	D
EBS, AI, or GOA	Combined A/B season January 20 - June 10 40% of annual TAC		Combined C/D season June 11 - October 31 60% of annual TAC	
CH-RFRPA	A season Jan. 20 - Mar. 31 catch limit*	B season Apr. 1 - Jun. 10 catch limit*	C season Jun. 11 - Aug. 21 catch limit*	D season Aug. 22 - Oct. 31 catch limit*

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23 * The catch limit will be calculated as a factor of half of the combined seasonal allowance for the overall management
24 area multiplied by the ratio of the biomass inside critical habitat to the biomass outside of critical habitat (B_{inCH}/B_{outCH})
25

26 **9.3.1 Description of Measures Required in the EBS, AI and GOA**

27
28 **Gulf of Alaska**

- 29
30 1. NMFS shall amend the FMP for Groundfish of the Gulf of Alaska to include a new
31 global control rule (discussed above) and apply the global control rule if pollock or
32 Pacific cod are determined to be in Tier 3b.
33
34 2. NMFS shall promulgate regulations that establish the following closure areas in the
35 GOA:
36
37 A. 3 nm no-entry zones for listed critical habitat rookeries (Table 9.3)
38 2. 3 nm no fishing zones for critical habitat haulouts and those additional haulouts
39 identified in the RFRPAs
40 C. Pollock and Pacific cod fishery exclusion zones in 80,926 km² (56%) of the
41 CH/RFRPA area in the GOA (Fig. 9.1 and Tables 9.1 and 9.2). CH-RFRPA
42 areas open and closed to pollock and Pacific cod fisheries are discussed further
43 in the context of monitoring section 9.5.
44
45 3. NMFS shall promulgate regulations to temporally allocate the TAC in the Gulf of Alaska

1 as follows:
2

- 3 A. Pollock and Pacific cod trawl fisheries shall be prohibited between November 1 -
4 January 20.
- 5 B. Two seasons that shall begin on January 20 and June 11 for trawl fisheries and
6 on January 1 and June 11 for non-trawl fisheries.
- 7 3. The 2 seasons shall be apportioned 40% and 60% of the TAC, respectively.
- 8 D. Four seasons in open CH-RFRPA area that shall begin, respectively, on January
9 20, April 1, June 11, and August 22 and shall be allocated a ratio of 20:20:30:30
10 of the TAC, respectively, multiplied by the ratio of biomass in the open area of
11 CH-RFRPA to the amount of biomass in the 3-digit management area (e.g., 610,
12 620/630, and 640).
- 13 E. No fishing for Pacific cod in CH-RFRPA areas between November 1 - January
14 20.

15
16 4. NMFS shall promulgate regulations to spatially allocate the TAC in the Gulf of Alaska
17 as follows:
18

- 19 A. Pollock and Pacific cod TAC shall be allocated to 3-digit management areas on a
20 seasonal basis as currently done, e.g., statistical areas 610, 620/630, and 640.
- 21 B. Pollock harvest limits shall be specified for open CH-RFRPA areas in 610, 620,
22 and 630 (Figure 2.5) based on the seasonal proportions of biomass within open
23 CH-RFRPA areas to the amount in the entire 3-digit management area (average
24 catch proportion used as a proxy for biomass).
- 25 C. Pacific cod harvest limits shall be specified for open CH-RFRPA areas in 610,
26 620, and 630 based on the seasonal proportions of biomass within open CH-
27 RFRPA areas to the amount in the entire 3-digit management area (average catch
28 proportion used as a proxy for biomass).

29
30 **Eastern Bering Sea**
31

- 32 1. NMFS shall amend the FMP for Groundfish Fisheries in the Bering Sea and Aleutian
33 Islands Area to include a new global control rule (discussed above) and apply the global
34 control rule if pollock or Pacific cod are determined to be in Tier 3b.
- 35
36 2. NMFS shall promulgate regulations that establish the following closure areas in the EBS:
37
 - 38 A. 3 nm no-entry zones for listed critical habitat rookeries (Table 9.3).
 - 39 2. 3 nm no fishing zones for critical habitat haulouts and those additional haulouts
40 identified in the RFRPAs (Table 9.3).
 - 41 C. Pollock and Pacific cod fishery exclusion zones in 91,844 km² (82%) of the CH-
42 RFRPA area in the EBS (Fig. 9.1 and Table 9.1). CH-RFRPA areas open and
43 closed to pollock and Pacific cod fisheries are discussed further in the context of
44 the monitoring of effects in section 9.5.
- 45
46 3. NMFS shall promulgate regulations to temporally allocate the TAC in the EBS as
47 follows:
48
 - 49 A. Pollock, Atka mackerel, and Pacific cod trawl fisheries shall be prohibited
50 between November 1 - January 20.

- B. Two seasons that shall begin on January 20 and June 11 for trawl fisheries and on January 1 and June 11 for non-trawl fisheries.
 - 3. The two seasons shall be apportioned 40% and 60% of the TAC, respectively.
 - D. Four seasons in open CH-RFRPA area that shall begin, respectively, on January 20, April 1, June 11, and August 22 and shall be allocated a ratio of 20:20:30:30 of the TAC, respectively, multiplied by the ratio of biomass in the open area of CH-RFRPA to the amount of biomass in the 3-digit management area.
 - E. No fishing for Pacific cod in CH-RFRPA areas between November 1 - January 20.
4. NMFS shall promulgate regulations to spatially allocate the TAC in the EBS as follows:
- A. Pollock and Pacific cod TACs shall be allocated to open CH-RFRPA areas based on the seasonal proportions of biomass within open CH-RFRPA areas to the amount in the entire management area (average catch proportion used as a proxy for biomass).

Aleutian Islands

- 1. NMFS shall amend the FMP for the Groundfish Fisheries of the Bering Sea and Aleutian Islands Area to include a new global control rule (discussed above) and apply the global control rule if pollock or Pacific cod are determined to be in Tier 3b.
- 2. NMFS shall promulgate regulations that establish the following closure areas in the AI:
 - A. 3 nm no-entry zones for listed critical habitat rookeries (Table 9.3)
 - 2. 3 nm no fishing zones for critical habitat haulouts and those additional haulouts identified in the RFRPAs
 - C. Pollock and Pacific cod, and Atka mackerel fishery exclusion zones in 59,794 km² (61%) of the CH-RFRPA area in the AI (Fig. 9.1 and Table 9.1). CH-RFRPA areas open and closed to pollock, Pacific cod, and Atka mackerel fisheries are discussed further in the context of the monitoring of effects in section 9.3.
- 3. NMFS shall promulgate regulations to temporally allocate TAC in the AI as follows:
 - A. Pollock, Atka mackerel, and Pacific cod trawl fisheries shall be prohibited between November 1 - January 20.
 - B. Two seasons that shall begin on January 20 and June 11 for trawl fisheries and on January 1 and June 11 for non-trawl fisheries.
 - 3. The two seasons shall be apportioned 40% and 60% of the TAC respectively.
 - D. Four seasons in open CH-RFRPA area that shall begin, respectively, on January 20, April 1, June 11, and August 22 and shall be allocated a ratio of 20:20:30:30 of the TAC, respectively, multiplied by the ratio of biomass in the open area of CH-RFRPA to the amount of biomass in the 3-digit management area.
 - E. No fishing for Pacific cod in CH-RFRPA areas between November 1-January 20.
- 4. NMFS shall promulgate regulations to spatially allocate TAC in the AI as follows:
 - A. Pollock and Pacific cod TACs shall be apportioned to area 12 and a limit

established for area inside of the CH-RFRPA area, based on seasonal biomass distribution.

- B. Atka mackerel TAC shall be apportioned to 3-digit management areas as currently recommended (EBS combined with area 541). In management area 541 (and the EBS), the limit within CH-RFRPA area 12 is based on the proportion of the area < 200 m depth within area 541.
- C. Atka mackerel TACs in 542 and 543 shall be apportioned to areas outside CH-RFRPA area 13 only.

9.3.2 Specifics and Examples of the RPA in EBS

The following is a description of the seasonal TAC apportionments available to the fishery inside CH-RFRPA areas and a discussion of how they are determined.

EBS Pollock

Monthly proportions of pollock biomass in critical habitat (assumed to be equivalent to the CH-RFRPA area in the EBS) were estimated by NMFS (2000). The biomass distribution in critical habitat (percentages) for the appropriate months for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were averaged to get a seasonal percentage. The proportion of pollock biomass in open critical habitat (area 7) was determined using the average catch percentage in area 7 in 1998-99 multiplied by the fraction of the EBS total biomass in the CH-RFRPA area by season (Table 9.4).

For example, the area 7 A-season catch limit in open critical habitat is the product of:

- 52% (the percentage of biomass in CH-RFRPA in the A-season),
- 20% (the percentage of TAC apportioned to the A-season, or half the A/B TAC allocation of 40 %) and
- 70% (the percentage of 1998-99 CH-RFRPA catch caught in area 7),

which equals 7.3%.

Harvest amounts are based on an assumed 2001 TAC of 1.3 million mt. The global control rule did not modify the maximum ABC because BSAI pollock is above the B₄₀ threshold.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 520,000 mt		C + D (60 % annual TAC) 780,000 mt	
Limit inside Area 7	max 7.3 % annual TAC 94,900 mt	max 4.6 % annual TAC 59,800 mt	max 0.9% annual TAC 11,700 mt	max 1.4 % annual TAC 18,200 mt

EBS Pacific cod

Monthly proportions of Pacific cod biomass in critical habitat (assumed to be equivalent to the CH-RFRPA area in the EBS) were estimated by NMFS (2000). The biomass distribution in critical habitat (percentages) for the appropriate months for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were averaged to get a seasonal percentage. The proportion of pollock biomass in open

critical habitat (area 7) was determined using the average catch percentage in area 7 in 1998-99 multiplied by the fraction of the EBS total biomass in CH-RFRPA area by season (Table 9.4)

For example, the area 7 A-season catch limit is the product of:
 82% (the percentage of biomass in CH-RFRPA in the A-season),
 20% (the percentage apportioned to the A-season), and
 42% (the percentage of 1998-99 CH catch caught in area 7),
 which equals 6.9%.

Based on the average proportions of the biomass in the Bering Sea and Aleutian Islands subareas, harvest amounts are based on the assumption that the Bering Sea represents 88 percent of the Plan Team's recommended BSAI ABC, or $(.88)(188,000) = 165,440$ mt. The Plan Team's recommended BSAI ABC (188,000 mt) is less than the maximum ABC derived from the Global control rule (204,618 mt), and is used accordingly.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 66,176 mt		C + D (60 % annual TAC) 99,264 mt	
Limit inside Area 7	max 6.9 % annual TAC 11,415 mt	max 1.3 % annual TAC 2,151 mt	max 2.5 % annual TAC 4,136 mt	max 6.0 % annual TAC 9,926 mt

9.3.3 Specifics and Examples of the RPA in the Gulf of Alaska

The following is a description of the seasonal TAC apportionments available to the fishery inside CH-RFRPA areas and a discussion of how they are determined.

GOA Pollock

Monthly proportions of pollock biomass in critical habitat (assumed to be equivalent to the CH-RFRPA areas in the GOA) were estimated by NMFS (2000). The percentages for the appropriate months for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were averaged to get a seasonal percentage. The proportion of pollock biomass in areas 1, 3, and 5 were determined using the average catch percentage in areas 1, 3, and 5 in 1998-99 multiplied by the fraction of the GOA total biomass in CH-RFRPA area by season and management area (i.e. 610, 620, 630, and 640; Table 9.4).

For example, the area 5 (610) A-season catch limit is the product of:
 28% (the percentage of GOA ABC allocated to 610 in the A-season),
 20% (the percentage apportioned to the A-season), and
 85% (the percentage of A-season pollock biomass in CH that is in area 5),
 which equals 4.8%.

The 2001 GOA pollock ABC as recommended by the Plan Team is 105,810 mt. This ABC is greater than the maximum ABC derived from the global control rule (86,922 mt). For purposes of the calculations below, therefore, the assumed TAC is 86,922 mt. This is the total of the pollock ABCs for the western-central GOA (81,882 mt) plus the East Yakutat-SE Outside (6,460 mt) minus the Prince

1 William Sound GHL (1,420 mt). The federally managed pollock TAC in the western and central GOA is
 2 80,462 mt; overall W-C apportionments are listed below, followed by area-specific apportionments.
 3

4 **GOA – Area 610** Assumes 28% of GOA ABC in area 610 during A/B; 41% of GOA ABC in area 610
 5 during C/D

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 9,122 mt		C + D (60 % annual TAC) 19,808 mt	
Limit inside CH-RFRPA	max 4.8 % annual TAC 3,863 mt	max 4.8 % annual TAC 3,863 mt	max 2.1 % annual TAC 1,711 mt	max 2.1 % annual TAC 1,711 mt

12
 13 **GOA – Area 620** Assumes 60% of GOA ABC in area 620 during A/B; 24% of GOA ABC in area 620
 14 during C/D.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 19,628 mt		C + D (60 % annual TAC) 11,766 mt	
Limit inside CH-RFRPA	max 10.7% annual TAC. 8,591 mt	max 10.7% annual TAC 8,591 mt	max 4.6 % annual TAC 3,665 mt	max 4.6% annual TAC 3,665 mt

21
 22 **GOA – Area 630** Assumes 8% of GOA ABC in area 630 during A/B; 32% of GOA ABC in area 630
 23 during C/D.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 2,640mt		C + D (60 % annual TAC) 15,512mt	
Limit inside CH-RFRPA	max 0.1 % annual TAC 86 mt	max 0.1 % annual TAC 86 mt	max 2.2% annual TAC 1,800 mt	max 2.2 % annual TAC 1,800 mt

1 **GOA – Area 640** Assumes 2.5% of GOA ABC in area 640

2 Season	A	B	C	D
3 Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
4 TAC outside 5 CH-RFRPA	A + B (40 % annual TAC) 794 mt		C + D (60 % annual TAC) 1,192 mt	
6 Limit inside 7 CH-RFPRA	max 0.2 % annual TAC 158 mt	max 0.2 % annual TAC 158 mt	max 0.3 % annual TAC 237 mt	max 0.3 % annual TAC 237 mt

8
9 **GOA Pacific cod**

10
11 Monthly proportions of Pacific cod biomass in critical habitat (assumed to be equivalent to the CH-
12 RFRPA area in the GOA) were estimated by NMFS (2000) (Table 9.4). The percentages for the
13 appropriate months for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were
14 averaged to get a seasonal percentage.
15

16 For example, the area 5 (610) A-season catch limit is the product of:

- 17 35% (the percentage of GOA ABC allocated to 610),
- 18 95% (the percentage in CH in the A-season in 610),
- 19 20% (the percentage apportioned to the A-season), and
- 20 25% (the percentage of 1998-99 610 A-season CH catch caught in area 5),
21 which equals 1.7%.

22
23 The GOA 2001 Pacific cod ABC as recommended by the Plan Team is 67,800 mt. This ABC is less than
24 the ABC derived from the Global Control Rule (76,707 mt) and is used accordingly. This ABC level
25 would be further reduced by up to 25% to provide for the Alaska State managed cod fishery. The
26 apportionments below are not reduced to reflect the State water fishery.
27

28 **GOA – Area 610** Amounts based on assumed GOA 2001 TAC of 24,000 mt, which is equal to the Area
29 610 ABC recommended by the GOA Plan Team.

30 Season	A	B	C	D
31 Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
32 TAC outside 33 CH-RFRPA	A + B (40 % annual TAC) 9,600 mt		C + D (60 % annual TAC) 14,400 mt	
34 Limit inside 35 CH-RFPRA	max 1.7 % annual TAC 1,153 mt	max 0.1 % annual TAC 68 mt	max 0.1% annual TAC 68 mt	max 0.1 % annual TAC 68 mt

1 **GOA – Area 620/630** Amounts based on assumed GOA 2001 TAC of 38,650 mt, which is equal to the
 2 Area 620/630 ABC recommended by the GOA Plan Team.

3 Season	A	B	C	D
4 Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
5 TAC outside 6 CH-RFRPA	A + B (40 % annual TAC) 15,460 mt		C + D (60 % annual TAC) 23,190 mt	
7 Limit inside 8 CH-RFRPA	max 8.0 % annual TAC 5,424 mt	max 2.2 % annual TAC 1,492 mt	max 3.7 % annual TAC 2,508 mt	max 3.8 % annual TAC 2,576 mt

9
 10 **GOA – Area 640** Amounts based on assumed GOA 2001 TAC of 4,750 mt, which is equal to the Area
 11 640 ABC recommended by the GOA Plan Team.

12 Season	A	B	C	D
13 Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
14 TAC outside 15 CH-RFRPA	A + B (40 % annual TAC) 1,900 mt		C + D (60 % annual TAC) 2,850 mt	
16 Limit inside 17 CH-RFRPA	max 0.4 % annual TAC 271 mt	max 0.2 % annual TAC 135 mt	max 0.2 % annual TAC 135 mt	max 0.3 % annual TAC 203 mt

18 9.3.4 Specifics and Examples of the RPA in the AI

19
 20
 21 The following is a description of the seasonal TAC apportionments available to the fishery inside CH-
 22 RFRPA areas and a discussion of how they are determined.

23 **AI Pollock**

24
 25
 26 Monthly proportions of pollock biomass in critical habitat (assumed to be equivalent to the CH-RFRPA
 27 area in the AI) were estimated by NMFS (2000) (Table 9.4). The percentages for the appropriate months
 28 for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were averaged to get a seasonal
 29 percentage. The proportion of pollock biomass in areas 12 and 13 were determined on the basis of the
 30 relative catch distributions in each area from the 1998 fishery. ABC is not apportioned among the three
 31 management areas in the Aleutian Islands.

32
 33 For example, the area 12 A-season catch limit is the product of:

- 34 52% (the percentage in CH in the A-season),
- 35 8% (the percentage of pollock catch in 1998 in areas 12 and 13 that came from area 12), and
- 36 20% (the percentage apportioned to the A-season),
- 37 which is 0.9%.

38
 39 In the AI, pollock ABC as recommended by the Plan Team for 2001, is 23,800 mt, which is equal to the
 40 maximum ABC derived from the global control rule and is used accordingly.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 9,520 mt		C + D (60 % annual TAC) 14,280 mt	
Limit inside CH-RFRPA	max 0.9 % annual TAC 214 mt	max 1.0 % annual TAC 238 mt	max 1.8 % annual TAC 428 mt	max 1.7 % annual TAC 404 mt

AI Pacific cod

Monthly proportions of Pacific cod biomass in critical habitat (assumed to be equivalent to the CH-RFRPA area in the AI) were estimated by NMFS (2000) (Table 9.4). The percentages for the appropriate months for each season (A=Jan-Mar, B=Apr-Jun, C=Jun-Aug, and D=Aug-Oct) were averaged to get a seasonal percentage. The proportion of Pacific cod biomass in areas 12 and 13 was determined on the basis of the relative catch distributions in each area from the 1998 fishery. ABC is not apportioned among the three management areas in the Aleutian Islands.

For example, the area 12 A-season catch limit is the product of:

- 79% (the percentage in CH in the A-season),
 - 87% (the percentage of P. cod catch in 1998-99 in areas 12 and 13 that came from area 12), and
 - 20% (the percentage apportioned to the A-season),
- which is 13.7%.

Based on the average proportions of the biomass in the Bering Sea and Aleutian Islands subareas, harvest amounts are based on the assumption that the Aleutian Islands represents 12 percent of the Plan Team's recommended BSAI ABC, or $(.12) \times (188,000) = 22,560$ mt. The Plan Team's recommended BSAI ABC (188,000 mt) is less than the maximum ABC derived from the global control rule (204,618 mt), and is used accordingly.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 9,024 mt		C + D (60 % annual TAC) 13,536 mt	
Limit inside CH-RFRPA	max 13.7 % annual TAC 3,090 mt	max 7.4 % annual TAC 1,669 mt	max 4.4 % annual TAC 993 mt	max 9.7 % annual TAC 2,188 mt

BSAI Atka mackerel

The proportion of Atka mackerel biomass within the CH-RFRPA area is not thought to vary seasonally. Furthermore, it was assumed that the proportion inside was directly proportional to the percentage of Atka mackerel habitat (< 200 m depth) in the CH-RFRPA area. Survey information provides relative biomass by 3-digit management area, and the proportions of area < 200 m depth inside the CH-RFRPA area provide the relative proportions of biomass inside. For the area outside of CH-RFRPA, the four

seasons were combined by averages of the A/B and C/D seasons.

For example, the area 12 A-season catch limit is the product of:

- 75% (the percentage of biomass within CH-RFRPA area 12 in area 541),
 - 20% (the percentage of ABC apportioned to the A-season), and
 - 11% (the percentage of AI Atka mackerel biomass in area 541),
- which equals 1.7%.

The BSAI Atka Mackerel ABC as recommended by the Plan Team for 2001 is 58,700 mt. This ABC is less than the ABC derived from the Global Control Rule (97,254 mt) and is used accordingly.

BSAI – Eastern Aleutians/Bering Sea (541/BS) Amounts based on assumed area 541 2001 TAC apportionment of 6,600 mt, which is the Area 541 ABC recommended by the BSAI Plan Team.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 2,640 mt		C + D (60 % annual TAC) 3,960 mt	
Limit inside CH-RFRPA	max 1.7 % annual TAC 998 mt	max 1.7 % annual TAC 998 mt	max 2.5 % annual TAC 1,468 mt	max 2.5 % annual TAC 1,468 mt

BSAI – Central Aleutians (542) Amounts based on assumed AI district 542 2001 TAC apportionment of 28,500 mt, which is the Area 542 ABC recommended by the BSAI Plan Team. Fishing is prohibited within CH-RFRPA areas.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 11,400 mt		C + D (60 % annual TAC) 17,100 mt	

BSAI – Western Aleutians (543) Amounts based on assumed area 543 2001 TAC apportionment of 23,600 mt, which is the Area 543 ABC recommended by the BSAI Plan Team. Fishing is prohibited within CH-RFRPA areas.

Season	A	B	C	D
Season dates	Jan 20 - Mar 31	Apr 1 - Jun 10	Jun 11 - Aug 21	Aug 22 - Oct 31
TAC outside CH-RFRPA	A + B (40 % annual TAC) 9,440 mt		C + D (60 % annual TAC) 14,160 mt	

9.4 How the RPA Avoids Jeopardy and Adverse Modification

9.4.1 The approach used

The ESA imposes on federal agencies a duty to insure that their actions will not jeopardize listed species or destroy or adversely modify their designated critical habitat. Although the ESA does not define the

1 term “jeopardize,” implementing regulations provide:

2
3 “Jeopardize the continued existence of” means to engage in an action
4 that reasonably would be expected, directly or indirectly, to reduce
5 appreciably the likelihood of both the survival and recovery of a listed
6 species in the wild by reducing the reproduction, numbers, or
7 distribution of that species.
8

9 50 C.F.R. § 402.02. The regulations also define “adverse modification” as:

10
11 “Destruction or adverse modification” means a direct or indirect
12 alteration that appreciably diminishes the value of critical habitat for
13 both the survival and recovery of a listed species. Such alterations
14 include, but are not limited to, alterations adversely modifying any of
15 those physical or biological features that were the basis for determining
16 the habitat to be critical.
17

18 50 C.F.R. § 402.02. The ESA clearly establishes two separate standards by which agency actions must be
19 judged. The jeopardy standard focuses on the continued existence of the listed species itself, requiring
20 examination of the effects of agency action on the species’ reproduction, population and range. Adverse
21 modification, in contrast, addresses the effects of agency action on the species’ habitat, focusing on
22 impacts to the particular qualities that make the habitat critical to the survival and recovery of the listed
23 species. Although there is considerable overlap between these two standards in our evaluation of the
24 groundfish fisheries, our assessment of the likelihood of jeopardy examines *the population’s response*
25 while our assessment of adverse modification examines the effects on *the availability of an adequate*
26 *prey field inside critical habitat*. The adequacy of the RPA must also be evaluated in terms of these same
27 two standards.
28

29 The preceding analysis in this biological opinion supports a determination that certain groundfish
30 fisheries currently authorized by the FMP are likely to jeopardize the continued existence of endangered
31 Steller sea lions and adversely modify their critical habitat. These determinations result from available
32 evidence of competitive interaction between the fisheries for pollock, Atka mackerel and Pacific cod and
33 Steller sea lions. This competitive interaction, occurring at the global, regional and local scales has been
34 shown to jeopardize the continued existence of Steller sea lions by interfering with their foraging
35 opportunities for the three major prey species resulting in reduced reproduction and survival. The
36 reduction in survival and reproduction has enhanced decline in the numbers of sea lions relative to an
37 unfished action area. Scientific evidence suggests that the same competitive interaction also has been
38 shown to adversely modify the critical habitat designated for Steller sea lions by reducing the availability
39 of the prey field at temporal and spatial scales relevant to foraging sea lions. Because this competitive
40 interaction is the basis for both the determinations of jeopardy and adverse modification of critical
41 habitat, the RPA avoids jeopardy and adverse modification by requiring FMP amendments that protect
42 both the population from the adverse competitive effects of the fisheries but also protect both the
43 availability of an adequate prey field inside critical habitat.
44

45 The global control rule is required to avoid both jeopardy and adverse modification, as detailed in
46 subsection in section 9.4.2 (below). The *regional and local scale* effects of competitive interaction are
47 avoided by requiring the combination of actions specified in the RPA which eliminate, or appreciably
48 reduce, the intensity of the interactions themselves. The RPA avoids jeopardy and adverse modification,
49 using the suite of actions contained herein, at all three scales where the competitive interactions occur, as
50 follows.

1 In Section 6.4.2.6, a series of seven questions was used to identify the areas of overlap between the
2 foraging habits of Steller sea lions and the harvesting patterns of individual groundfish fisheries. The
3 greater the degree of overlap, reflected by affirmative answers to the seven questions, the greater the
4 concern that competitive interaction occurred. The procedure identified the pollock, Pacific cod and
5 Atka mackerel fisheries as having such competitive interactions with Steller sea lions (for each fishery,
6 affirmative answers were given to all seven questions). The logic used in this biological opinion to avoid
7 jeopardy and adverse modification, therefore, is to apply an RPA, containing multiple elements, to the
8 very same points of overlap (reflected in the series of questions) that define the interactions in the first
9 place. That is, the RPA prescribes actions for individual forms of overlap, which when combined, reduce
10 the competitive interaction, independent of its sources. It is because the competitive interaction arises
11 from multiple points of overlap, evident at global, regional and local scales, that the RPA must also
12 require multiple actions.
13

14 While the most comprehensive approach to eliminating competition would suggest prescribing actions
15 under the RPA that addressed every point of overlap, this is not necessary to avoid jeopardy and adverse
16 modification, nor is it possible without the complete elimination of fisheries because the interactions with
17 Steller sea lions arise not only from the actions of the groundfish fisheries themselves, but also from the
18 behavior, foraging habits and life history patterns of Steller sea lions. However, a number of means of
19 avoiding the competitive interaction are available. Questions 1 and 2 in Section 6.4.2.6 address the
20 extent to which Steller sea lions forage on target fish species. Given the answer to questions 1 and 2 is
21 positive, consideration of the overlaps underlying questions 3 - 7 identify those opportunities to avoid
22 jeopardy and adverse modification by constraining, rather than eliminating fisheries for pollock, Pacific
23 cod and Atka mackerel.
24

25 **Question 3 - Prey Size Overlap**

26
27 Interactions between groundfish fisheries and Steller sea lions could not be eliminated by
28 complete separation of the two components in the size of fish caught. Fishing gear is not so
29 selective by size that complete separation in this dimension is possible. Furthermore, since
30 Steller sea lions eat a wide range of sizes of juvenile and adult fish, management actions
31 addressing this problem would have to restrict fisheries to sizes smaller than juvenile fish which
32 is an unreasonable fisheries management practice. Thus, the RPA does not attempt to eliminate
33 interactions stemming from overlap in the size of pollock, Atka mackerel and Pacific cod
34 consumed and harvested.
35

36 **Question 4 - Spatial Overlap**

37
38 Reducing competitive interactions between groundfish fisheries and Steller sea lions by spatial
39 partitioning is a viable approach. The extent to which partitioning would be useful, however,
40 varies with both the use of the area by the forager and the extent to which harvesting occurs in
41 that area. For instance, complete spatial partitioning could only be accomplished by prohibiting
42 groundfish fisheries from operating in all places where Steller sea lions forage on pollock,
43 Pacific cod, and Atka mackerel. This would include all designated critical habitat plus adjoining
44 areas of the continental shelf and slope in the Gulf of Alaska, Bering Sea and Aleutian Islands.
45 However, this approach fails to account for the concept that rare instances of overlap should not
46 be treated the same as instances of intense overlap. Instead, this RPA prescribes partitioning
47 rules that reflect differing use of habitat by Steller sea lions. In particular, areas in close
48 proximity to haulouts and rookeries (e.g., within 3 nm) are fully partitioned, i.e., closed to
49 fishing, as is the majority of critical habitat.
50

1 **Question 5 - Temporal Overlap**
2

3 Temporal partitioning of groundfish fisheries and Steller sea lions is also a viable approach. As
4 in the case of spatial partitioning, it must be applied when the competitive interactions are most
5 likely to occur. There are seasonal differences in the frequency of occurrence of pollock, Pacific
6 cod and Atka mackerel in sea lion diets that suggest a targeted application of temporal RPA
7 actions. In particular, the RPA requires partitioning of critical habitat during the winter season
8 as it is a particularly sensitive period for Steller sea lions.
9

10 **Question 6 - Depth Overlap**
11

12 Interactions between groundfish fisheries and Steller sea lions within the water column could not
13 be completely partitioned. On a diurnal basis, fish move up and down in the water column such
14 that their availability at depths used by sea lions would be affected if fisheries were only
15 restricted to shallower or deeper depths. Use of the water column by fish and sea lions is not an
16 action that can reasonably be affected through groundfish fishery management measures.
17

18 **Question 7 - Overlap with Temporally/Spatially Concentrated Fisheries**
19

20 Competitive interactions between groundfish fisheries and Steller sea lions that result from the
21 temporal and spatial concentration of prey removals are addressed by the RPA. The intention of
22 these measures is to disperse the fisheries removals in time and space, thereby reducing the
23 likelihood that fisheries would reduce the availability of prey for Steller sea lions (i.e., cause
24 localized depletions). In addition, the RPA disperses these fisheries both on a regional scale and
25 at the local scale of relevance to an individual foraging sea lion. Temporal and spatial
26 allocations of groundfish TAC that reduce the intensity of fishing effort in a particular season at
27 the regional scale is the first of two steps. The second step is to ensure that the TAC
28 apportionment is harvested in a dispersed manner such that the rate of removal does not exceed
29 the rate of replenishment across local areas used by foraging Steller sea lions. This involves full
30 protection of all rookeries and haulouts within 3 nm. The RPA also requires four seasonal
31 harvest limits in open CH-RFRPA areas that distributes harvest over time and in a manner
32 consistent with seasonal distribution of biomass in these areas.
33

34 As described in Section 6 of this biological opinion, the pollock cooperatives established under
35 the AFA have resulted in significant changes to the fishing pattern of the Bering pollock fishery
36 since 1998. These cooperatives have greatly increased the spatial and temporal dispersion of this
37 fishery (Appendix 4). The positive correlation of dispersion of fishing effort in the Bering Sea
38 and Aleutian Islands is expected to continue.
39

40 **9.4.2 The Global Control Rule**
41

42 The global control rule operates at the ecosystem or global scale, and as such, it is neither a partitioning
43 or dispersive action. It is a revised, more precautionary adjustment procedure for pollock, Pacific cod or
44 Atka mackerel stocks in the EBS, AI and GOA at small stock sizes (below $B_{40\%}$) than currently exists
45 under the FMP. The effect of using the global control rule is increased likelihood that the stock is
46 maintained at or above the target stock size by reducing the exploitation rate at low stock sizes thereby
47 insuring a more sable source of available prey for Steller sea lions..
48

49 NMFS has concluded that the best available scientific evidence is consistent with the hypothesis that the
50 trajectory of the western population of Steller sea lions in the absence of a groundfish fishery in the

1 action area (GOA and BS) would only be marginally different than the trajectory of Steller sea lions
2 under a groundfish fishery managed under the RPA described herein. NMFS would have expected the
3 sea lion population in question to have equilibrated at a population level somewhere in the vicinity of the
4 estimated population size between 1991 (i.e., approximately 49,000 animals) and 1998 (i.e.,
5 approximately 39,000 animals) absent a fishery, although it is certainly possible that the sea lion
6 population absent a fishery would have continued to decline. NMFS believes that this reduced
7 equilibrium value relative to the equilibrium value thought to exist in the 1970s was caused by a
8 combination of changes in the ecosystem due to the regime shift as well as changes in the ecosystem
9 caused by commercial fishing.

11 Specifically, after implementing the RPA and the prosecution of the groundfish fishery over the next 5
12 years, NMFS anticipates that the western population of sea lions will respond similarly to a population of
13 sea lions in an unfished environment. That is, the number of sea lions in western Alaska may increase in
14 abundance, equilibrate at its current level, or even decline in abundance, but this same population
15 response would occur absent a fishery. This change in the underlying growth rate would primarily result
16 from increases in survival and reproduction of sea lions in the areas closed to pollock, Pacific cod, and
17 Atka mackerel fishing. However, NMFS expects sea lion numbers, in the parts of critical habitat open to
18 fishing and in areas outside critical habitat open to fishing, to also benefit from this RPA.

19
20 In 2001, three stocks are projected to be below $B_{40\%}$ in 2001: GOA pollock, BSAI Pacific cod, and AI
21 Atka mackerel. The GOA pollock ABC using the current tier 3B adjustment would have been 105,810
22 mt, but using the global control rule reduces the maximum ABC by almost 19,000 mt to 86,922 mt.
23 Similarly, the maximum BSAI Pacific cod ABC using the current tier 3B adjustment would have been
24 213,800 mt but using the global control rule reduces the maximum ABC by about 9,200 mt. The BSAI
25 Plan Team, however, recommended a further reduction to 188,000 mt to account for uncertainty. The
26 BSAI Atka mackerel maximum ABC would have been 99,165 mt, but the global control rule reduces the
27 maximum ABC to 97,250 mt. The BSAI Plan Team further reduced this amount to 59,000 mt to account
28 for uncertainty. The remaining stocks (EBS pollock, AI pollock and GOA Pacific cod) are all projected
29 to be above $B_{40\%}$ in 2001 and would thus require no F adjustment under the global control rule.
30 Consequently, using the global control rule will, on average, maintain larger populations of pollock, Atka
31 mackerel, and Pacific cod in the ecosystem as Steller sea lion prey.

32 33 **9.4.3 Avoidance of niche overlap**

34
35 RPA elements that completely separate sea lions and groundfish fisheries operate at global and regional
36 scales, and in both temporal and spatial dimensions. The single temporal element that prohibits trawl
37 fishing for pollock, Pacific cod, and Atka mackerel between November 1 and January 20 completely
38 eliminates interactions in critical habitat between sea lions and these trawl fisheries for 22% of the year.
39 As such, this action operates at a global or ecosystem scale. More complete separation in critical habitat
40 is necessary in this period because sea lions at this time are most sensitive to prey availability. For the
41 remaining 78% of the year, dispersive actions taken at finer temporal and spatial scales (discussed below)
42 are also necessary to avoid jeopardy and adverse modification.

43
44 There are two spatial partitioning elements which operate at the regional scale. The first is the creation
45 of 3 nm no-fishing zones around all haulouts, which will be added to the existing closures around most
46 rookeries of the western stock of Steller sea lions. In the GOA, EBS and AI, a total of 139 3 nm no-
47 fishing zones will exist that will completely protect all pups (most recent count of 9,373) and non-pups
48 (most recent count of 25,187) from disturbances associated with fishing in close proximity to important
49 terrestrial breeding and resting habitat. This action closes a total of 11,800 km², or 3%, of Steller sea lion
50 critical habitat to all fishing by federally permitted vessels.

1 The second spatial partitioning element is the exclusion of all fisheries for pollock, Pacific cod, and Atka
2 mackerel from approximately 66% of the CH-RFRPA areas in the GOA, EBS, and AI. This protects a
3 total of 6,904 pups and 14,112 adult and juvenile seas lions (most recent counts) by closing a total of
4 223,540 km² from regional effects of the pollock, Pacific cod, and Atka mackerel groundfish fisheries.
5

6 **9.4.4 Dispersing harvest under the RPA**

7

8 The actions described above provide significant protection for Steller sea lions from the pollock, Pacific
9 cod and Atka mackerel fisheries with respect to competitive interactions with Steller sea lions. However,
10 other measures are necessary to avoid jeopardy and adverse modification caused by unconstrained
11 fisheries in the remaining 34% of open critical habitat and other open times and areas. These measures
12 disperse fishing effort at regional and local scales to reduce the effects of groundfish fisheries on prey
13 availability for sea lions to negligible or background levels. At the regional scale, one temporal and two
14 spatial actions are taken, while at the local scale, a single temporal measure is used.
15

16 The use of two seasonal allocations of TAC and four associated harvest limits in CH-RFRPA areas
17 disperses fishing effort throughout the year. Season start dates are set at January 20 and June 11 for the
18 A/B and C/D seasons respectively. TAC is allocated to two combined seasons using the guideline
19 developed in previous biological opinions, which stated that no more than 40% of the TAC could be
20 allocated to the first seasons in order to reduce fishing effort in the winter.
21

22 Once the seasonal TAC is set, it is spatially dispersed throughout the open CH-RFRPA fishing area based
23 on the best estimates of seasonal biomass distribution. The RPA will limit the effects of fishing effort
24 and resulting catch evenly in critical habitat, and provide incentives to vessels to fish outside critical
25 habitat. Thus, within the GOA, EBS, and AI, pre-existing management areas are used to spatially
26 allocate TAC. These include management areas 610, 620, 630, and 640 in the GOA, the EBS, and areas
27 541, 542, and 543 in the AI. Furthermore, harvest limits within open portions of critical habitat in each
28 management area are set seasonally based again on our best estimates of biomass distribution. Relative
29 to recent levels, setting of harvest limits within open critical habitat will reduce from 1998 and 1999
30 levels the percentage of annual pollock caught in critical habitat by 31-72%, annual Pacific cod caught in
31 critical habitat by 27-62%, and annual Atka mackerel caught in critical habitat by 64% in the GOA, EBS,
32 and AI.
33

34 **9.5 Monitoring the effects of the action as modified by the RPA**

35

36 Over the past decade the NPFMC has noted the importance of assessing the efficacy of conservation
37 measures intended to promote the recovery of the western population of Steller sea lions. Development
38 and implementation of further sea lion protective regulations that restrict normal fishing operations
39 would be enhanced by the NMFS establishment of a well-designed monitoring program that would be
40 used to ascertain the extent to which the implemented measures to promote the recovery of sea lions. To
41 this end, NMFS has incorporated into its RPA a monitoring program that will allow for such an
42 assessment.
43

44 As noted earlier, the approach recommended in this Biological Opinion is reasonably designed to avoid
45 jeopardy and adverse modification of critical habitat. The overall approach of the RPA involves the
46 following strategy: (1) protect a substantial number of the rookeries and haulouts used by Steller sea
47 lions and the marine environment immediately offshore of these areas from disturbance associated with
48 commercial fishing for the three primary prey species (i.e., pollock, Atka mackerel, and Pacific cod), (2)
49 protect a substantial portion of critical habitat from the effects of commercial fishing on the three primary
50 prey species, (3) ensure that adequate forage resources are available to support a sustained population of
November 30, 2000

1 Steller sea lions in excess of 34,600 animals, and (4) in areas where fishing is allowed, ensure that
2 fishing does not create areas where Steller sea lions are not able to successfully forage.
3

4 Therefore, the RPA is designed to close adequate portions of critical habitat to commercial fishing for the
5 three primary prey species of groundfish, while imposing restrictions on fishing operations in areas open
6 to fishing to avoid local depletion of prey resources for Steller sea lions. This approach of creating areas
7 open and closed to fishing operations forms the basis for the monitoring program designed to assess the
8 efficacy of the RPA and any associated conservation measures.
9

10 As indicated earlier, the action area described in section 3 was divided into three primary blocks, referred
11 to as blocks I, II, and III. Each of these blocks was then further subdivided into 13 CH-RFRPA areas, as
12 described in Table 9.1. The following objectives were used in defining the 13 areas: (1) at least 50% of
13 critical habitat should be closed to fishing; (2) the area closed to fishing should protect approximately
14 50% of the non-pup population and 75% of the areas where pups are born; (3) the underlying trend in
15 open and closed areas in each of the three blocks should be statistically equivalent to allow for
16 independent evaluation of the efficacy of the RPA in the three blocks; and (4) after a period no-longer
17 than six years of monitoring, there should be an acceptable likelihood of successfully detecting an
18 improvement in the status of Steller sea lions in each of the three blocks.
19

20 **9.5.1 Design detail**

21
22 The 13 areas depicted in Figure 9.1 were assigned to blocks as follows: Block I is comprised of areas 1,
23 2, 3, 4, 5, and 6; Block II comprised of 7, 8, 9, 10, 11; Block III- 12 and 13. The following areas - 1, 3, 5,
24 7 and 12- were assigned an open status while the remaining areas were assigned a closed status relative to
25 fishing operations for pollock, Pacific cod and Atka mackerel. Tables 9.1, 9.2, and 9.3 provide a
26 description of the areas within each block, the specific rookeries or haulouts enclosed, and the total area
27 open/or closed for each block and sub area. Table 9.5 provides a summary of the non-pups, non-pup
28 counting sites, pups, and pup counting sites by each of the 13 areas. Table 9.6 provides a summary of the
29 number of non-pups and pups by block and open/closed areas.
30

31 **9.5.2 Assumptions**

32
33 Several assumptions were made in defining the blocks and areas described in section 9.5. These include
34 the following. The first assumption is that the population trends in open and closed areas within each
35 block are similar (see Tables 9.7 and 9.8 for summaries of non-pup count and trend data by blocks). The
36 second assumption is that there is a comparable amount of fishing in each of the open and closed areas in
37 each block. As displayed in Table 9.9, substantial amounts of catch are reported for each of the closed
38 and open areas in each of the three blocks. The third assumption is that there is adequate statistical
39 power over the next 5- 10 years to detect improvement were the subpopulations in each of the closed
40 areas to increase their respective trends in abundance by 4% per year; this will be discussed further
41 below. In general, after 6 years of annual surveys, there is adequate statistical power to ascertain whether
42 the RPA contributes to the recovery of sea lions, where the underlying condition is that the fishery is
43 contributing to the decline of sea lions in the action area, and adequate statistical power to ascertain that
44 the RPA is not a primary factor in understanding the current decline, where the underlying condition is
45 that the fishery is not contributing to the decline of sea lions in the action area.
46

47 **9.5.3 Interpreting results of the monitoring project**

48
49 As already stated, the goal of the monitoring project is to ascertain the extent to which the implemented
50 conservation measures promote the recovery of sea lions (i.e. remove jeopardy and adverse modification).

1 Consequently, the population trend of sea lions after implementation of the conservation measures will
2 be compared to the population trend before implementation, both in closed and open areas. This
3 information, in combination with other studies, will allow an investigation regarding whether the
4 conservation measures are effective.
5

6 It is expected that any effect of fishing will be removed in the closed areas. Therefore, the population
7 trend in the closed areas is expected to improve after implementation. Similarly, the conservation
8 measures in the open areas are also thought to be adequate to remove any major effect of fishing on sea
9 lions. If this is true, the population trend in the open areas is also expected to improve after
10 implementation.
11

12 Therefore, if the population trend after implementation improves relative to trends over the past decade
13 in both the open and closed areas, this can be interpreted as evidence that the conservation measures have
14 removed the effect of fishing. If the population trend improves in closed areas but not in open areas, this
15 can be interpreted as evidence that fishing effects were removed in the closed area but not in the open
16 area.
17

18 Alternatively, if fishing activities are not a contributing factor to the decline of sea lions, then the
19 expectation is that there will be no change in the population trend in either open or closed areas.
20 Therefore, if there is no improvement in the population trend, this can be interpreted as evidence the
21 fishery has not been a contributing factor to the decline of sea lions.
22

23 The four possible outcomes are described in Table 9.10. Outcomes 1 and 2 are consistent with the
24 hypothesis that the fishery is contributing to the decline of sea lions, whereas Outcomes 3 and 4 are not
25 consistent with that hypothesis.
26

27 It is important to think about the specific interpretation of each of these possible outcomes. For example,
28 consider the case where Outcome 1 is the result, because the population trend improves in both open and
29 closed areas. This result would be consistent with the hypothesis that the fishery has contributed to the
30 decline of sea lions. However, an improvement in the population trend after the implementation of
31 conservation measures will only represent a correlation – it does not prove causation. For this reason, it
32 will be important to consider the results of additional studies to provide additional evidence that is
33 consistent with the hypothesis that the fishery contributed to the decline of sea lions. For example,
34 evidence that more fish are available to sea lions in critical habitat would be an additional piece of
35 evidence that would help to prove causation. Another example would be a decrease in a measure of
36 foraging effort of sea lions would be an indication that more fish were available to sea lions.
37

38 There will still always be the possibility that an improvement in population trend has, by coincidence,
39 occurred for another reason, such as an improvement in environmental conditions for sea lions that is
40 unrelated to the fishery. For this reason, it will remain important to consider information on
41 oceanographic conditions and other environmental variables to see if environmental conditions have
42 happened to have undergone a large change that is coincident with the implementation of the
43 conservation measures.
44

45 Particularly for block I (Gulf of Alaska), it may be useful to simultaneously consider trends in the eastern
46 stock of Steller sea lions in Southeast Alaska. While environmental conditions may differ between these
47 two areas, a concurrent improvement in the population trend (of a similar magnitude) of sea lions in
48 Southeast Alaska would be consistent with the hypothesis that there has been an improvement in
49 environmental conditions for sea lions in the region that is independent of the fishery in the Gulf of
50 Alaska.

1 Additionally, the population trend in the closed area can be compared to the population trend in the open
2 area. If the fishery has contributed to the decline of sea lions, and the population trend has improved in
3 both areas, there are two possible situations. First, the population trend could be similar between the
4 closed and open areas. This would indicate that the conservation measures in the open areas had an
5 equivalent effect as the conservation measures put in place in the closed areas. Second, if the population
6 trend in the closed area is greater than the population trend in the open area, this indicates the
7 conservation measures in the open area have led to an improvement in conditions for sea lions, but not as
8 great an improvement as was seen in the closed area.

9
10 Similar reasoning can be used in the other three possible outcomes to aid in the interpretation of the
11 results from the monitoring program.

12 13 **Criteria for concluding the population trend is better**

14
15 After a specified period of time, a decision will need to be made regarding whether the
16 population trend is better, as expected. A quantitative criteria to be used in the decision making
17 process is described here.

18
19 Consistent survey protocols have been in place since 1991. Therefore, the period 1991-2000 can
20 serve as a baseline of past trends in abundance. There were six surveys over this time period. A
21 linear regression on the natural logarithm of abundance can be used to provide an estimate of the
22 previous rate of change of the population. The exponential rate of change of a population is
23 traditionally called r , so the old trend of the population will be called r_{old} .

24
25 New management actions will be implemented in 2001. Therefore, there is an expectation that
26 the population trend to follow the trajectory that Stellers would follow in an unfished
27 environment from the year 2000 onwards. If annual surveys are performed, by the year 2003
28 there will be 4 surveys to examine the trend of the population, with 6 surveys by year 2005 and 8
29 surveys by year 2007. This new trend (r_{new}) can be compared to the old trend to examine the
30 effect of the management actions.

31
32 The verbal statement of the monitoring criteria is-

33
34 “The new trend of the population is expected to be better than the old trend of the
35 population.”

36
37 This can be turned into a quantitative statement regarding the old and new trends of the
38 population.

39
40 “The new rate of change of the population, r_{new} , is expected to be greater than the old rate
41 of change of the population, r_{old} , or

$$42$$
$$43 r_{new} > r_{old}$$
$$44$$

45 Both these quantities (r_{old} and r_{new}) are estimated from data, and have some uncertainty which can
46 be represented as a distribution. It is easier to think in terms of a single distribution for a single
47 quantity, rather than attempt to compare two distributions. Therefore, an equivalent statement is

$$48$$
$$49 r_{new} - r_{old} > 0.0$$
$$50$$

1 If the difference between the new and old growth rates is greater than 0.0, this indicates the
2 population trend has improved. However, this would include the possibility of such a small
3 improvement as to be of no real consequence to the population. Therefore, we can ask the
4 question, has the population trend improved by a biologically relevant amount? An improvement
5 of at least 0.01 (or 1% per year) would be biologically relevant. This would lead to a slight
6 modification of the above statement.
7

8 The last piece to specify in establishing this quantitative criteria is to specify how certain the
9 results have to be to conclude that the new trend is better than the old trend.
10

11 **Statistical procedures**

12

13 One standard statistical method for determining when a new trend is considered better than an
14 old trend would be to specify a null hypothesis (H_0) that there is no difference in the trends, and
15 then do a statistical significance test which would reject or not reject this null hypothesis.
16 Rejection of the null hypothesis would be considered evidence that the trend has improved, and
17 an inability to reject the null hypothesis would be considered evidence that the trend has not
18 improved (though one should bear in mind the issue of how much statistical power there was to
19 correctly reject a false null hypothesis – this issue will be considered below).
20

$$21 \quad H_0: r_{\text{new}} - r_{\text{old}} < 0.01$$

22

23 A significance level is chosen for rejecting the null hypothesis, such as $\alpha=0.10$. This means that
24 under the null hypothesis, if the data that were observed (or more extreme data) were less than α
25 probable, the null hypothesis would be rejected. α represents the Type I error rate, which is the
26 probability of incorrectly rejecting a true null hypothesis.
27

28 Statistical power is the probability that a false null hypothesis will correctly be rejected. One
29 minus power is referred to as the Type II error rate – the probability of incorrectly not rejecting a
30 false null hypothesis. The statistical power to detect a trend is known to be a function of the
31 precision of the abundance estimates, the magnitude of the trend, the length of the monitoring
32 period, and the significance level chosen (Gerrodette 1987). The statistical power to detect a
33 difference in the population trend before and after conservation measures was calculated for the
34 open and closed area in each block (Table 9.11).
35

36 Although Table 9.11 indicates how much statistical power there is to detect an improvement in
37 one area, it does not completely address the issue of how often one will correctly come to the
38 correct conclusion. The 4 possible outcomes specified in Table 9.10 depend each depend upon
39 the results of two statistical tests – the detection or not of a trend in both the closed and the open
40 area. To directly investigate this issue, simulations were performed to determine how often one
41 would reach the correct outcome. Because there are 4 possible different outcomes, 4 different
42 simulations were performed with different underlying scenarios: (1) trend increases by 0.04 in
43 both closed and open areas, (2) trend increases by 0.04 in closed area but remains the same in the
44 open area, (3) trend remains the same in both closed and open areas, and (4) trend remains the
45 same in the closed area but increases by 0.04 in the open area. In each scenario, the frequency
46 with which the correct outcome was chosen was tabulated (Table 9.11).
47

48 The major issue is determining whether there is evidence that the fishery has contributed to the
49 decline in sea lions. Making a mistake in this conclusion can be called a major error, whereas
50 making a mistake only regarding how well the conservation measures are working in the open

1 area can be considered a minor error, relatively speaking. For example, if the true condition is
2 that the trend has improved in both the closed and open areas, then Outcome 1 would be the
3 correct conclusion, concluding Outcome 2 would be a minor error, and concluding Outcome 3 or
4 4 would be a major error. Therefore, for each scenario, the frequency with which the conclusion
5 was correct or only a minor error was tabulated (Table 9.12). This represents the rate at which a
6 major error is avoided.
7

8 The probability of making an error after 6 years of data varies depending upon what actually
9 happens, and it varies by area because the data are more or less precise in different areas.
10 Although these error rates are not exactly Type I and II error (because they depend on more than
11 one statistical test), they are closely related concepts. In particular, in the same way that raising
12 the Type I error rate will lower the Type II error rate, and vice versa, there will be trade-offs
13 between the error rates for the various outcomes.
14

15 **Decision analysis**

16
17 An alternative to the significance testing approach is to use decision theory (Berger 1985). The
18 mathematical theory of decision making under uncertainty has been established for several
19 decades (Raiffa and Schlaiffer 1961). A brief summary of the approach is this — list the
20 possible options in the decision, assign a relative undesirability of each possible outcome under
21 each possible decision option (referred to as the relative “loss”), calculate the probability of each
22 outcome, then assign an expected loss to each possible decision option by summing the loss for
23 all outcomes weighted by their respective probability. The preferred decision is the option with
24 the smallest expected loss.
25

26 In the context here, there are four possible options for the decision, which were outlined in
27 Table 9.10. There are also four possible true conditions that may result, which are the same four
28 possibilities outlined in Table 9.10. If the trend actually is better in both the closed and open
29 areas, and one then concludes that the trend is better in both areas, this is a correct decision, and
30 there is no “loss” associated with making that decision (Table 9.13). However, arriving at any
31 other conclusion represents an error, and so a relative loss value will be attached to each of these
32 possible errors. To reflect the difference outlined above between major and minor errors,
33 different relative loss values are assigned to the different types of errors. Still, considering the
34 situation where the true condition is that the trend has improved in both the closed and open
35 areas (Table 9.10), concluding that the trend has improved in the closed area but not the open
36 area (Outcome 2) is a minor error, and has a relatively low loss value assigned to it. However,
37 concluding that Outcome 3 or 4 has happened will be a major error, as the conclusion will be that
38 the fishery has not contributed to the decline of sea lions when in fact it has. Therefore, a
39 relatively higher loss value is assigned to these major errors (Table 9.13).
40

41 The other three columns in Table 9.13 outline the loss values that are assigned to possible errors
42 for the three other possible true situations. Major errors are found in the upper right four boxes
43 and in the lower left four boxes. The upper right area represents situations where the fishery has
44 not contributed to the decline of sea lions, but a conclusion has been reached that it has. This can
45 be termed an over-protection error – sea lions have been over-protected. The lower left area
46 represents situations where the fishery has contributed to the decline of sea lions, but a
47 conclusion has been reached that the fishery has not contributed – this can be termed an under-
48 protection error. If an over-protection error is considered to be as equally bad as an under-
49 protection error, they should be assigned the same relative loss value. This is the case in Table
50 9.13.

1 Once the loss functions are specified, the decision analysis can be performed by calculating the
2 probability the population trend after conservation measures is greater than 0.01 better than the
3 population trend before conservation measures. The result of the decision analysis will be to
4 choose one of the four decision options. As was done for the significance test approach outlined
5 above, simulations were performed for the same four scenarios to calculate the probability that
6 the correct decision will be made in each case, for each block (Table 9.14).
7

8 The resulting probabilities of making the correct decision under the specified scenarios are a
9 function of both the loss functions that were specified and the actual data. It can be seen that the
10 decision analysis approach leads to some trade-offs in the error rates between the four possible
11 outcomes. A choice of different loss functions will lead to different trade-offs in the four
12 possible error rates, and across the three different blocks. The probability of making the correct
13 decision will not be the same in each block, because the expected precision of the data in each
14 block is different.
15

16 In summary, NMFS will use a statistically valid approach to ascertaining whether the results
17 from the monitoring program are consistent with the expectation that the RPA, as implemented,
18 to contribute to the recovery of the western population of Steller sea lions. Further, as necessary,
19 these same data will be used in subsequent consultations to determine whether additional
20 restrictions on the groundfish fishery in Alaska are necessary or whether restrictions
21 implemented for the 2001 fishery could be relaxed, at least in some areas.
22

23 Because this biological opinion has concluded that continued operation of groundfish fisheries in
24 the BSAI and GOA are likely to jeopardize the continued existence of the endangered western
25 population of Steller sea lions and destroy or adversely modify critical habitat that has been
26 designated for them, NMFS' Office of Sustainable Fisheries is required to notify NMFS's Office
27 of Protected Resources of its final decision on the implementation of the reasonable and prudent
28 alternatives (50 CFR 402.15).
29

30 **9.6 Risk Analysis**

31

32 The RPA proposed in this biological opinion should allow the western population of Steller sea lion to
33 equilibrate at a population level in excess of 34,600 animals. Specifically, NMFS anticipates that the
34 subpopulation of sea lions that primarily occupy and forage within the areas closed to fishing over the
35 next 8 years will follow the trajectory that Stellers would follow in an unfished environment. Removing
36 effects of fishing could result in population trends consistent with the eastern population of Steller sea
37 lions, which are increasing in abundance at a rate of 1% - 2% per year, rather than continue to decline at
38 approximately 3% per year. NMFS also expects that the subpopulation of sea lions that primarily occupy
39 and forage within areas open to fishing over the next 8 years will equilibrate in abundance rather than
40 continue to decline at approximately 2% per year. This increase in the underlying growth rate would
41 primarily result from increases in survival and reproduction of sea lions in the areas closed to pollock,
42 Pacific cod, and Atka mackerel fishing. However, NMFS expects sea lion numbers in the parts of critical
43 habitat open to fishing and in areas outside critical habitat open to fishing to also benefit from elements
44 of the RPA which require adjustments to F for fish stocks below 40% of their unfished biomass, greater
45 evenness in the way species-specific TACs are allocated seasonally, and substantial cuts in the maximum
46 removal rates in open critical habitat especially in the winter season, and closures within 3 nm of all
47 rookeries and haulouts.
48

49 As an unlikely worst case scenario, only sea lions in areas closed to fishing would benefit. If the average
50 benefit in these 8 areas were approximately equal to the magnitude of the current decline (i.e., 4% per
November 30, 2000

1 year), the resulting population change of sea lions in the areas closed to fishing over the next 8 years
2 would be to follow the trajectory that Steller sea lions would follow in an unfished environment, while
3 sea lions in areas open to fishing would decline at approximately 2% per year. The underlying growth
4 rate of the entire western population of Steller sea lion over the next 8 years would be an annual decline
5 of 0.7% or a loss to the population over the 8 year time period of 5%. Were this scenario realized,
6 NMFS would detect a difference in population growth rates between sea lions in the areas open to fishing
7 and closed to fishing within the next six years and would respond by increasing the percentage of critical
8 habitat closed to fishing or otherwise restricting one of more of the fisheries that compete with Steller sea
9 lions for prey. Given the relatively large size of the western Steller sea lion population, a loss of animals
10 on the order of 5% would not result in a significant increase in the likelihood that this population will
11 become extinct in the foreseeable future.

1
2
3 **10 INCIDENTAL TAKE STATEMENT**
4
5
6

7 Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of
8 endangered and threatened species, respectively, without special exemption. Take is defined as to harass,
9 harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct.
10 Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an
11 otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental
12 to and not intended as part of the agency action is not considered to be prohibited taking under the Act
13 provided that such taking is in compliance with the reasonable and prudent measures and terms and
14 conditions of this Incidental Take Statement.
15

16 The measures described below are non-discretionary, and must be undertaken by NMFS so that they
17 become binding conditions of any grant or permit issued, as appropriate, for the exemption in section
18 7(o)(2) to apply. NMFS has a continuing duty to regulate the activity covered by this incidental take
19 statement. If NMFS (1) fails to require the applicant to adhere to the terms and conditions of the
20 incidental take statement through enforceable terms that are added to the permit or grant document,
21 and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective
22 coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NMFS must
23 report the progress of the action and its impacts on the species as specified in the incidental take
24 statement. [50 CFR 402.14(I)(3)]
25

26 An incidental take statement specifies the impact of any incidental taking of endangered or threatened
27 species. It also provides reasonable and prudent measures that are necessary to minimize impacts and
28 sets forth terms and conditions with which the action agency must comply in order to implement the
29 reasonable and prudent measures.
30

31 **10.1 Steller Sea Lion**

32
33 **Amount or Extent of Incidental Take**
34

35 In this biological opinion, NMFS has determined that both direct and indirect take of Steller sea lions is
36 reasonably likely to occur. The annual direct take levels specified in previous biological opinions for
37 BSAI and GOA groundfish fisheries were 30 and 15, respectively. The NPFMC, working with industry,
38 has made extensive efforts to reduce the amount of direct take of Steller sea lions to the extent
39 practicable, and therefore, NMFS expects similar direct take levels to continue.
40

41 Indirect take of Steller sea lions is much more difficult to describe. A certain percentage of the Steller
42 sea lion population is lost each year, but NMFS is not able to enumerate that loss or to recover the bodies
43 to determine the cause of death. It is NMFS biological opinion that the action will result in some level of
44 sub-lethal harm throughout the range of Steller sea lions by reducing prey availability such that the
45 animal may have to forage longer, travel to an alternate location, or abandon the trip altogether. This
46 may result in decreased body fat, longer foraging trips which might make an animal more vulnerable to
47 predation, and decreased fecundity. However, the RPA required by this biological opinion, is likely to
48 reduce these events. Additionally, the large closed areas important to Steller sea lion foraging will
49 provide a refuge for many animals from any competition at all. Therefore, although some animals are
50 likely to be adversely affected through indirect mechanisms, this is likely to be a local and rare
51 occurrence.

1 **Effect of the Take**

2
3 In this biological opinion, NMFS has determined that the level of anticipated take under the reasonable
4 and prudent alternative is not likely to jeopardize the continued existence of the western population of
5 Steller sea lions or result in the destruction or adverse modification of its designated critical habitat.

6
7 **Reasonable and Prudent Measures**

8
9 NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to
10 minimize the impacts from fisheries considered in this opinion to the listed Steller sea lion.

- 11
12 1. NMFS shall monitor the take of Steller sea lions incidental to the BSAI and GOA groundfish
13 fisheries.
14
15 2. NMFS shall monitor all groundfish landings.
16
17 3. NMFS shall monitor the location of all groundfish catch to determine whether the catch was
18 taken inside critical habitat (zones 1-13) or outside of critical habitat in the BSAI or GOA.
19
20 4. NMFS shall monitor vessels fishing for groundfish inside specified closed areas for pollock,
21 Pacific cod, and Atka mackerel (as required by the RPA) to determine if they are directed fishing
22 for those species.
23

24 **Terms and Conditions**

25
26 In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must comply with the
27 following terms and conditions, which implement the reasonable and prudent measures described above.
28 These terms and conditions are non-discretionary.

- 29
30 1. NMFS shall obtain counts of all Steller sea lions taken in the BSAI and GOA groundfish
31 fisheries through its observer program. The observer program must be statistically robust enough
32 to ensure that the direct take of Steller sea lions is accurately enumerated.
33
34 2. Monitoring of groundfish landings shall be sufficient enough to provide inseason managers with
35 the appropriate information to determine if critical habitat harvest limits required under the RPA
36 are exceeded. This information should also be sufficient to determine appropriate closures by
37 sector, gear type, or region as necessary.
38
39 3. Monitoring of the location of groundfish catch shall be sufficient to provide inseason managers
40 with statistically valid estimates of catch inside critical habitat (areas 1-13) and catch outside
41 critical habitat by NMFS management area. This information must be robust enough to ensure
42 that critical habitat harvest limits for Atka mackerel, Pacific cod, or pollock are not exceeded in a
43 manner inconsistent with the RPA objective for an evenly dispersed fishery.
44
45 4. Monitoring of vessel location while directed fishing shall be sufficient to ensure that any vessel
46 engaged in illegal activity, within a closure area for the conservation of Steller sea lions, is
47 detected and appropriate action taken against the operators of that vessel.
48

49 **10.2 Salmon**

1 **Amount or Extent of the Take**

2
3 While it is not possible to identify individual listed fish that may be taken in a fishery, impacts to listed
4 fish can be limited by specifying limits in terms of either an exploitation rate or total catch. The catch of
5 listed fish will be limited specifically by the measures proposed to limit the total bycatch of chinook
6 salmon. Bycatch should be minimized to the extent possible and in any case should not exceed 55,000
7 chinook per year in the BSAI fisheries or 40,000 chinook salmon per year in the GOA fisheries. NMFS
8 does not anticipate that the proposed fisheries will take any steelhead ESUs.
9

10 **Effect of the Take**

11
12 In this biological opinion, NMFS has determined that the level of anticipated take under the reasonable
13 and prudent alternative is not likely to jeopardize the continued existence of any listed salmon or
14 steelhead or result in the destruction or adverse modification of designated critical habitat for those
15 species.
16

17 **Reasonable and Prudent Measures**

18
19 NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to
20 minimize the impacts from fisheries considered in this opinion to listed salmon and steelhead.
21

- 22 1. The NPFMC and NMFS, Alaska Region shall ensure there is sufficient NMFS-certified observer
23 coverage such that the bycatch of chinook salmon and “other” salmon in the BSAI and GOA
24 groundfish fisheries can be monitored on an inseason basis.
25
- 26 2. The NPFMC and NMFS, Alaska Region shall monitor bycatch reports inseason to ensure that the
27 bycatch of chinook salmon does not exceed 55,000 fish per year in the BSAI fisheries and 40,000
28 fish per year in the GOA fisheries.
29
- 30 3. The NPFMC and NMFS, Alaska Region shall monitor bycatch reports of chinook salmon in the
31 Bering Sea subarea, inseason, so that the Chinook Salmon Savings Area can be closed to directed
32 fishing for pollock with trawl gear before the limit is exceeded.
33

34 **Terms and Conditions**

35
36 In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must comply with the
37 following terms and conditions, which implement the reasonable and prudent measures described above.
38 These terms and conditions are non-discretionary.
39

- 40 1. NMFS’ Division of Sustainable Fisheries (Alaska Region) shall provide an annual report to the
41 NMFS Division of Protected Resources (Alaska Region) that details the results of its monitoring
42 of bycatch reports during each fishing season. These reports shall be submitted in writing within
43 one month of the new fishing year (February 1), and will summarize all statistical information
44 based on a January 1 through December 31 fishing year.
45
- 46 2. The NPFMC and NMFS, Alaska Region shall assess the various salmon savings areas on an
47 annual basis during the stock assessment process to determine the efficacy of those closed areas
48 and determine whether additional closed areas should be added to ensure that the bycatch of
49 salmon is limited to the maximum extent practicable.

11 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS believes the following conservation recommendations should be implemented. In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

11.1 Comprehensive Assessment Process

The present fishery management regime for federal groundfish fisheries in Alaska relies heavily on the fish stock assessment advice and analysis of fishery scientists at the Alaska Fisheries Science Center and the review of this analysis and advice by the Groundfish Plan Teams of the North Pacific Fishery Management Council (Council) and their Scientific and Statistical Committee. Marine mammal and marine bird experts have been assigned membership on these review teams to help provide information on possible interactions of fisheries with other species, particularly species listed under the ESA. Stock assessment scientists develop individual stock assessments that are compiled annually into a Stock Assessment and Fishery Evaluation (SAFE) Report of the NPFMC. Marine mammal and bird population trends, environmental changes, and changes in other parts of the ecosystem are also compiled into a separate chapter of the SAFE. Although this structure allows for some communication and review of fishery removal recommendations by consulting agency representatives and exchange of listed species trends with action agency representatives, such communication occurs at a level above the development of individual stock assessment advice. As such, the SAFE Report process and associated schedule for annual harvest specifications do not formally allow for analysis of fishery removal information at a time and space scale that might be needed to determine if the present nature of fishery removals could be interfering with listed species. It also currently does not provide for sufficient inclusion of the information on fisheries and the ecosystem into the assessment process.

The changing nature of fishery removals in time and space and nature of gear used are a particular concern. Target species fisheries may change the areas and seasons fished, sizes and species composition of fish removed, and the types of gear used by area and season. These factors can alter both the direct take of listed species in fisheries and indirect effects through types, sizes, and amounts of prey removed, in addition to alteration of essential fish habitat. In order to provide timely review of possible fishery interactions with listed species (and in the future on essential fish habitat), NMFS recommends a more comprehensive stock assessment process that includes a detailed analysis in which individual stock assessments would consider:

1. When and where the stock and the fishery on that stock tends to be concentrated,
2. What quantity of target and nontarget species is removed by area and season,
3. What sizes of fish are caught by area and season,
4. What amount of direct take of marine mammals and birds by area and season, and

1
2 5. Environmental influences on fish stock distribution and abundance.
3

4 This would allow for better analysis of the possible impacts of target fisheries on listed species and the
5 more proactive development of time/space harvest recommendations at the individual stock assessment
6 level that would minimize fishery interactions with listed species and essential fish habitat and prevent
7 jeopardy or modification of critical habitat of listed species in the future. Assessment of the cumulative
8 amounts of fishery removals by species, season and area, direct takes of mammals and birds by season
9 and area, and gear usage by season and area should also be determined since total removals of prey are
10 also important in the assessment of fishery interactions with listed species. This would be a progressive
11 movement towards what is now being termed a “comprehensive assessment” process that includes
12 multispecies considerations and risk analyses inside the stock assessment process.
13

14 **11.2 Minimizing the Ecosystem Effects of the “Race for Fish”**
15

16 Overcapitalized fisheries or fisheries that seek fish during a narrow space/time frame because of fish
17 aggregation, product or bycatch considerations have greater potential to produce localized depletion of
18 fish or to interfere with predators that also take advantage of fish that concentrate at certain times. The
19 comprehensive assessment process recommended above provides a means to identify those fisheries and
20 to develop target fishery-specific mitigation measures. However, NMFS, working with the NPFMC, also
21 should promote other means to reduce overcapitalization of fisheries and concentration of fisheries in
22 time and space. Fishery rationalization programs such as the Individual Fishing Quota (IFQ) program, the
23 Community Development Quota (CDQ) program, and the American Fisheries Act (AFA) cooperatives
24 have shown success in reducing the “footprint” of fisheries, especially at smaller time/space scales.
25 NMFS recommends an expansion of these type of approaches to rationalize all BSAI/GOA groundfish
26 fisheries along with the appropriate improvements to the existing catch monitoring programs (i.e.,
27 observer program, reporting and record keeping requirements, and vessel monitoring programs).
28

29 For an interim period until these programs are instituted, NMFS recommends that non-exempt AFA
30 catcher vessels be prohibited from participating in the directed fishery for GOA pollock and Pacific cod
31 to help reduce harvest rates of these species. The GOA fisheries for Pacific cod and pollock have yet to
32 be rationalized in a manner that would promote slower-paced and dispersed fishing activity.
33 The non-exempt AFA vessels have been determined by the NPFMC to have less dependency on the GOA
34 fisheries relative to Bering Sea fishing activity. The critical habitat limits for GOA pollock and Pacific
35 cod are relatively small and can be fully and effectively harvested by local area small boat fleets. While
36 the recommendation to prohibit AFA non-exempt vessels from fishing in the GOA pollock and Pacific
37 cod fisheries would be an allocative action, NMFS believes that this interim measure would facilitate
38 slower catch rates within the GOA pollock and Pacific cod fisheries and help to temporally disperse
39 fishing effort, particularly in critical habitat.
40

41 NMFS also recommends that management and stock assessment staff review the boundaries of regulatory
42 areas in the Gulf of Alaska to determine whether management of critical habitat limitations could be
43 facilitated by adjusting these boundaries to minimize the number of open or closed critical habitat areas
44 that span more than one regulatory area. In particular, NMFS believes that the management of open
45 critical habitat area 5 harvest limits could be advantaged by moving the eastern boundary of Gulf of
46 Alaska Regulatory Area 610 eastward from 159 degrees W. Longitude to 157 degrees W. Longitude.
47 This would provide a separation between open critical habitat area 5 and closed critical habitat area 4.
48

1 **11.3 Further Exploration and Reduction of Uncertainty**
2

3 There are many sources of uncertainty in the assessment of prey abundance for listed species prey
4 population abundance. The Global Control Rule to address effects of the overall exploitation strategy on
5 the FMP area-wide reduction of important forage has been designated as one of the necessary RPAs to
6 mitigate jeopardy for Steller sea lions in this biological opinion. This modified control rule is proposed
7 mainly because of our uncertainty about present estimates of fish stock biomass. However, there are
8 other methods to reduce uncertainty in the estimation of fish population abundance. NMFS recognizes
9 that one of the main sources of uncertainty in the determination of present biomass levels of listed
10 species prey is the variability associated with survey biomass estimates. This uncertainty can produce
11 unintended higher exploitation rates on these prey populations and could thus influence prey availability
12 to listed species. If it seems more appropriate in the future, NMFS recommends the incorporation of an
13 adjustment to accommodate uncertainty associated with survey biomass estimates as a replacement for
14 the modified Global Control Rule. The recommended adjustment would be a reduction of the fishing
15 mortality rate associated with the allowable biological catch (F_{ABC}) from the maximum allowable fishing
16 mortality rate ($\max F_{ABC}$), by an amount that varies directly with the uncertainty (variance) associated
17 with the survey biomass estimates. This will ensure that the ABC will be reduced for those species with
18 highly variable survey biomass estimates, as a precautionary harvest strategy. The adjustment for survey
19 biomass uncertainty should be applied to all target species with biomass estimates.
20

21 **11.4 Further Research on the Extent and Nature of Steller Sea Lion Foraging Habitat**
22

23 There is still great uncertainty about the extent of Steller sea lion foraging habitat. Platform of
24 Opportunity (POP) observations show that Steller sea lions are seen throughout much of the Bering Sea
25 outside of the presently designated critical habitat and pelagic foraging habitat. Observations obtained
26 from animals monitored with satellite-linked time-depth recorders has shown some percentage of animals
27 moving outside critical habitat, but not to the extent observed in the POP data. NMFS recommends more
28 research on the extent to which Steller sea lions utilize foraging habitat outside current critical habitat
29 limits.
30

31 **11.5 Incidental Take Statement for Alaska State Fisheries**
32

33 Alaska state fisheries, particularly salmon, herring, and Pacific cod, are likely to affect Steller sea lions
34 and thus may require an incidental take statement. Two alternatives for addressing this situation are: (1)
35 a consultation under section 7 of the Endangered Species Act if a federal action or significant federal
36 assistance is involved; or (2) state development of a habitat conservation plan. NMFS should assist
37 Alaska state officials on this issue.
38

39 **11.6 Information on Listed Salmon Species**
40

41 The following are conservation recommendations specific to listed salmon:
42

- 43 1. The NPFMC and NMFS, Alaska Region should improve estimates of the region-of-
44 origin and stock composition of the chinook salmon bycatch by increasing CWT
45 sampling rates as part of the mandatory salmon retention program, collecting and
46 analyzing scale samples, and employing additional stock identification techniques
47 applicable to the problem.
- 48 2. The NPFMC and NMFS, Alaska Region should use information collected during the
49 observer monitoring program to identify times and areas of high salmon abundance that
50

1 could be used to reduce salmon bycatch through regulatory action.

- 2
- 3 3. The NPFMC and NMFS, Alaska Region should encourage development of incentive
4 programs designed to reduce the bycatch of salmon in the NPFMC groundfish fisheries.
5

6 **11.7 Establish a NMFS Steller Sea Lion Team**

7

8 NMFS should establish a Steller Sea Lion Team to be responsible for ensuring that agency activities
9 related to Steller sea lions are adequately staffed on a full time basis and to ensure that established
10 schedules are maintained. This team would continue to work on the solutions to fishery/sea lion
11 interactions, oversee the review processes, and reinitiate consultation or revise the biological opinion if
12 necessary. The team, made up of 6 to 8 individuals, would include 3 to 5 NMFS managers and scientists
13 with both marine mammal and fishery expertise. Other team members could include scientists from the
14 States of Alaska and Washington, university professors, environmental organizations, industry
15 representatives, and the North Pacific Fishery Management Council.
16

17 **11.8 Initiate Scientific and Public Review of the Biological Opinion**

18

19 NMFS should submit the biological opinion for scientific and public review. Based on those reviews,
20 NMFS could reinitiate consultation if needed and make any necessary regulatory changes by the
21 beginning of the 2002 fishing year.
22

- 23 1. NMFS should initiate discussion with the National Academy of Sciences regarding a
24 review of the scientific basis for the biological opinion. Several NAS groups have
25 experience working on North Pacific issues and have provided useful reviews and
26 recommendations for Alaskan fisheries. However, it remains uncertain whether NAS
27 can provide the appropriate level of review with a completion date within 9 months.
28
- 29 2. NMFS should invite the five independent scientific experts who were retained to provide
30 initial comments on an earlier draft of the biological opinion to review the completed
31 document.
32
- 33 3. NMFS should consult with the Council to determine the best schedule for their review of
34 the biological opinion. NMFS will present the biological opinion to the Council in
35 December 2000.
36
- 37 4. NMFS should invite the State of Alaska task force, which was established to address
38 Steller sea lions/fisheries issues, to review the biological opinion and provide their
39 recommendations.
40
- 41 5. NMFS should hold public hearings on the biological opinion in Dutch Harbor, Kodiak,
42 Sand Point, Anchorage, and Seattle. To the extent possible, these meetings should be
43 held coincident with hearings held to facilitate the public review of the Draft
44 Supplemental Environmental Impact Statement on the Fishery Management Plans for the
45 federal groundfish fisheries off Alaska.
46
- 47 6. NMFS should consult with the Plaintiffs and others in the environmental community to
48 determine the best schedule and mechanism for their review of the biological opinion.
49

1 **11.9 Monitoring Program**
2

3 NMFS should expand current programs used to assess the effectiveness of this biological opinion and its
4 impacts on the fisheries, including:
5

- 6 1. The experimental design, which uses the groundfish fishery as part of the experiment, to
7 evaluate the role of the fishery in Steller sea lion population dynamics, including the
8 relative contribution of the fisheries among other factors that may be contributing to
9 Steller sea lion declines.
10
- 11 2. The quality and quantity of data concerning social, economic, and safety impacts of the
12 measures that result from this biological opinion on traditional fisheries in federal waters
13 off Alaska, e.g., catch rates, seafood quality and value, and bycatch rates of prohibited
14 and other species.
15

16 **11.10 Recovery Plan**
17

18 In 1992, NMFS published a final recovery plan for Steller sea lions. However, it is now out of date and
19 the Alaska Region has begun to look at assembling a new recovery team to revise the plan. NMFS
20 should begin this process within the next 6 months. Both industry and environmental organizations
21 should have an opportunity to provide input.
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12 REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the authorization of the Bering Sea and Aleutian Islands groundfish fisheries based on the FMP for the Bering Sea and Aleutian Islands groundfish; and authorization of the Gulf of Alaska groundfish fisheries based on the FMP for groundfish of the Gulf of Alaska. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or designated critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or designated critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation of consultation.

13 LITERATURE CITED

- Ackely, D., C. Blackburn, K. Brix, D. Clausen, J. Di Cosimo, R. Ferrero, L. Fritz, A. Grossman, J. Heifetz, P. Livingston, L.-L. Low, R. Merrick, E. Varosi, and D. Witherell. 1994. Ecosystem considerations, 1995. North Pacific Fisheries Management Council; Anchorage, Alaska.
- Agler, B.A., R.L. Schooley, S.E. Frohock, S.K. Katona, and I.E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. *J. Mamm.* 74:577-587.
- Aguilar, A., and C. Lockyer. 1987. Growth, physical maturity, and mortality of fin whales (*Balaenoptera physalus*) inhabiting the temperate waters of the northeast Atlantic. *Can. J. Zool.* 65:253-264.
- Ainley, D.G., C.S. Strong, H.R. Huber, T.J. Lewis, and S.H. Morrell. 1981. Predation by Sharks on Pinnipeds at the Farallon Islands. *Fish. Bull.* 78:941-945.
- Alaska Sea Grant. 1993. Is it food? Addressing marine mammal and seabird declines. Alaska Sea Grant; Fairbanks, Alaska.
- Albers, W.D., and P.J. Anderson. 1985. Diet of Pacific cod, *Gadus macrocephalus*, and predation on the northern pink shrimp, *Pandalus borealis*, in Pavlov Bay, Alaska. *Fish. Bull.* 83:601-610.
- Alderdice, D.F., and C.R. Forrester. 1968. Some effects of salinity and temperature on early development and survival of the English sole (*Parophrys vetulus*). *J. Fish. Res. Board Canada* 25:495-521.
- Allen, K.R. 1980. Conservation and management of whales. Univ. of Washington Press, Seattle.
- Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 66, 151 pp.
- Alton, M.S., and B.A. Megrey. 1986. Condition of the walleye pollock resource of the Gulf of Alaska as estimated in 1985. U.S. Dep. of Commer., NOAA Tech. Memo. NMFS F/NWC-106.
- Alton, M.S., M.O. Nelson, and B.A. Megrey. 1987. Changes in the abundance and distribution of walleye pollock (*Theragra chalcogramma*) in the western Gulf of Alaska (1961-1984). Comparative Biology, assessment, and management of gadoids from the North Pacific and Atlantic Oceans. *Fish. Res.*
- Alton, M.S., R.G. Bakkala, G.E. Walters, and P.T. Munro. 1988. Greenland turbot, *Rheinhardtius hippoglossoides*, of the Eastern Bering Sea and Aleutian Islands. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 71, 31 pp.
- Alverson, D.L. 1991. Commercial fisheries and the Steller sea lion (*Eumetopias jubatus*): the conflict arena. University of Washington, Fisheries Research Institute FRI-UW-9106. Seattle,

1 Washington.

2
3 Alverson, D.L. 1992. A review of commercial fisheries and the Steller sea lion (*Eumetopias jubatus*):
4 The conflict arena. Rev. Aquat. Sci. 6:203-256.

5
6 Anderson, P.J., J.E. Blackburn, and B.A. Johnson. 1997. Declines of forage species in the Gulf of
7 Alaska, 1972-1995, as an indicator of regime shift. Proceedings of the Forage Fishes in the
8 Marine Ecosystems Symposium. Alaska Sea Grant College Program, pp. 531-544.

9
10 Anderson, P.J., and J.F. Piatt. *In prep.* Trophic reorganization in the Gulf of Alaska following ocean
11 climate regime shift.

12
13 Anderson, P.J. and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean
14 climate regime shift. Marine Ecol. Progr. Series 189: 117-123.

15
16 Andrewartha, H.G. and L.C. Birch. 1954. The distribution and abundance of animals. The University of
17 Chicago Press; Chicago, Illinois.

18
19 Andrews, R.C. 1916. The sei whale (*Balaenoptera borealis* Lesson). mem. Am. Mus. Nat. Hist. New
20 Ser. 1(6):291-388.

21
22 Anonymous. 1987. Endangered fish and wildlife; approaching humpback whales in Hawaiian waters.
23 Fed. Reg.52(225, 23 Nov.):44912-44915 [50 CFR Part 222].

24
25 Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes
26 (Scorpaenidae) from B.C. coastal waters, 1977-79. Canadian Tech. Rep. of Fish. Aquat. Sci.
27 1048:57.

28
29 Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and
30 growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda Gonatidae) during
31 summer and fall in the western Bering Sea. Fish. Bull. 94:1-30.

32
33 Ashmole, N.P. 1963. The regulation of numbers of tropical oceanic birds. Ibis 103: 458-473.

34
35 Ashwell-Erickson, S. and R. Elsner. 1981. The energy cost of free existence for Bering Sea harbor and
36 spotted seals. Pages 869-899. In: D.W. Hood and J.A. Calder (eds.) The eastern Bering Sea shelf:
37 oceanography and resources. Volume Two. Office of Marine Pollution Assessment, National
38 Oceanic and Atmospheric Administration. University of Washington Press; Seattle, Washington.

39
40 Atkins, N., and S. L. Swartz (eds.). 1989. Proceedings of the workshop to review and evaluate whale
41 watching programs and management needs. November 14-16, 1988, Monterey, CA. Cent. Mar.
42 Conserv., Wash., D.C., 53 p.

43
44 Auster, P.J. and R.W. Langton. 1999. The effects of fishing of fish habitat. In Bananka (Ed.) Fish
45 Habitat: Essential Fish Habitat and Restoration. AFS Symposium 22: 150-187.

46
47 Bailey, K.M. 1989. Interaction between the vertical distribution of juvenile walleye pollock *Theragra*
48 *chalcogramma* in the eastern Bering Sea, and cannibalism. Mar. Ecol. Prog. Ser. 53:205-213.

49
50 Bailey, K.M., R.D. Brodeur, and A.B. Hollowed. 1996. Cohort survival patterns of walleye pollock,
November 30, 2000

- 1 *Theragra chalcogramma*, in Shelikof Strait, Alaska: a critical factor analysis. Fish. Oceanogr. 5:
2 179-188.
3
- 4 Bailey, K.M., and S.A.Macklin. 1994. Analysis of patterns in larval walleye pollock (*Theragra*
5 *chalcogramma*) survival and wind mixing events in Shelikof Strait, Gulf of Alaska. Mar. Fish.
6 Ecol. Prog. Ser. 113:1-12.
7
- 8 Baillie, J., and G. Groombridge (eds.). 1996. 1996 IUCN red list of threatened animals. IUCN, Gland,
9 Switzerland. 368 pp.
10
- 11 Baker, S.C., A. Perry, and G. Vequist. 1988. Conservation update-- Humpback whales of Glacier Bay,
12 Alaska. Whalewatcher, J. Am. Cetac. Soc. 22(3):13-17.
13
- 14 Bakkala, R.G. 1984. Pacific cod of the eastern Bering Sea. Internatl. N. Pac. Fish. Comm. Bull.
15 42:157-179.
16
- 17 Bakkala, R.G. 1993. Structure and historical changes in the groundfish complex of the eastern Bering
18 Sea. NOAA Tech. Rep. NMFS 114, 91 pp.
19
- 20 Bakkala, R.G., K. King, and W. Hirschberger. 1981. Commercial use and management of demersal fish.
21 Pages 1015-1036. In: D.W. Hood and J.A. Calder (eds). The eastern Bering Sea shelf:
22 oceanography and resources. Volume 2.
23
- 24 Bakkala, R.G., J. Traynor, K. Teshima, A.M. Shimada, and H. Yamaguchi. 1985. Results of cooperative
25 U.S.-Japan groundfish investigations in the eastern Bering Sea during June-November 1982.
26 U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-87, 448 pp.
27
- 28 Bakun, 1996. Patterns in the ocean: ocean processes and marine population dynamics. California Sea
29 Grant, Sacramento, California.
30
- 31 Balcomb, K., and G. Nichols. 1978. Western North Atlantic humpback whales. Rep. Int. Whal. Comm.
32 28:159-164.
33
- 34 Bannikov, A.G., I.S. Darevsky, and A.K. Rustamov. 1971. Zemnovodni i presmikaushchienya USSR.
35 Izdatelistvo "Misl, " Moscow. 304 pp.
36
- 37 Bannister, J.L. and E. Mitchell. 1980. North Pacific sperm whale stock identity: distributional evidence
38 from Maury and Townsend charts. Reports of the International Whaling Commission Special
39 Issue No. 2: 219-223.
40
- 41 Baraff, L. 1999. Select pinnipeds and fisheries of the New England and west coast regions of the United
42 States: trends and potential interactions. Unpublished report prepared for the Alaska Ecosystem
43 Program, National Marine Mammal Laboratory. Contract No. 40ABNF801451. National Marine
44 Mammal Laboratory; Seattle, Washington.
45
- 46 Baraff, L. S., and T. R. Loughlin. In Press. Trends and potential interactions between pinnipeds and
47 fisheries of New England and US west coast. Marine Fisheries Review.
48
- 49 Baraff, L. S. 1999. California sea lions and the coastal stock of Pacific whiting: abundance, distribution
50 and interactions. Contract Report No. 40ABNF801451, National Marine Mammal Laboratory,
November 30, 2000

1 7600 Sand Point Way, NE, Seattle, WA 98115.

- 2
- 3 Barlough, J.E., E.S. Berry, E.A. Goodwin, R.F. Brown, R.L. DeLong, and A.W. Smith. 1987.
- 4 Antibodies to marine caliciviruses in the Steller sea lion (*Eumetopias jubatus* Schreber). *J. of*
- 5 *Wildl. Dis.* 23:34-44.
- 6
- 7 Barlow, J. 1995. The abundance of cetaceans in California waters. I. Ship surveys in summer/fall 1991.
- 8 *Fish. Bull.* 93:1-14.
- 9
- 10 Barlow, J., R. L. Brownell, D. P. DeMaster, K. A. Forney, M. S. Lowry, S. Osmek, T. J. Ragen, R. R.
- 11 Reeves, and R. J. Small. 1995. U.S. Pacific marine mammal stock assessments 1995. U.S. Dep.
- 12 Commer., NOAA Tech. Memo. NMFS-SWFSC-219, 161 p.
- 13
- 14 Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S.
- 15 Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific marine mammal stock assessment: 1996.
- 16 U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-248, 223 p.
- 17
- 18 Baretta, L., and G.L. Hunt, Jr. 1994. Changes in the numbers of cetaceans near the Pribilof Islands,
- 19 Bering Sea, between 1975-78 and 1987-89. *Arctic* 47:321-326.
- 20
- 21 Barrett-Lennard, L.G., K. Heise, E. Saulitis, G. Ellis and C. Matkin. *In prep.* The impact of killer whale
- 22 predation on Steller sea lion populations in British Columbia and Alaska. Report for the North
- 23 Pacific Universities Marine Mammal Research Consortium, Vancouver, B.C.
- 24
- 25 Bartholomew, G.A. 1970. A model for the evolution of pinniped polygyny. *Evolution* 24:546-559.
- 26
- 27 Bauer, G.B. 1986. The behavior of humpback whales in Hawaii and modification of behavior induced
- 28 by human interventions. Ph.D. dissertation, University of Hawaii, Honolulu.
- 29
- 30 Beach, D. W., and M. T. Weinrich. 1989. Watching the whales: Is an educational adventure for humans
- 31 turning out to be another threat for endangered species? *Oceanus* 32(1):84-88.
- 32
- 33 Beamish, R.J. 1993. Climate and exceptional fish production off the west coast of North America. *Can.*
- 34 *J. Fish. Aquat. Sci.* 50:2270-2291.
- 35
- 36 Beddington, J.R. and R.M. May. 1982. The harvesting of interacting species in a natural ecosystem.
- 37 *Scientific American* 247: 63-69.
- 38
- 39 Berzin, A.A. 1971. *Kashalot*. [The sperm whale.] [In Russian.] Izd. "Pishchevaya Promyshlennost,"
- 40 Moscow, 367 pp. (Transl. by Israel Program Sci. Transl., 1972, 394 pp.) Available Natl. Tech.
- 41 Inf. Serv. , Springfield , VA, as TT71-50152/50160.
- 42
- 43 Berzin, A.A., and A.A. Rovnin. 1966. The distribution and migrations of whales in the northeastern part
- 44 of the Pacific, Chukchi and Bering Seas. *Izvestia TINRO* 58:179-207.
- 45
- 46 Berzin, A.A., and V.L. Vladimirov. 1981. Changes in abundance of whalebone whales in the Pacific
- 47 and Antarctic since the cessation of their exploitation. *Rep. Int. Whal. Comm.* 31:495-498.
- 48
- 49 Berzin, A.A., and A.V. Yablokov. 1978. Abundance and population structure of important exploited

- 1 cetacean species of the world ocean. Zool. Zh. 7(12):1771-1785.
- 2
- 3 Best, E.A., and F. St-Pierre. 1986. Pacific halibut as predator and prey. Int. Pac. Halibut Comm., P.O.
- 4 Box 95009, Seattle, WA 98145. Technical Report 21.
- 5
- 6 Best, P.B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-
- 7 186.
- 8
- 9 Beverton, R. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fishery Investigations,
- 10 Series II, Volume XIX, London. 533pp
- 11
- 12 Bickham, J.W., J.C. Patton, and T.R. Loughlin. 1996. High variability for control-region sequences in a
- 13 marine mammal: Implications for conservation and biogeography of Steller sea lions
- 14 (*Eumetopias jubatus*). J. Mammal. 77(1):95-108.
- 15
- 16 Bickham, J.W., et al. 1998. Genetic variability and population decline in Steller sea lions from the Gulf
- 17 of Alaska. Journal of Mammalogy 79:1390-1395.
- 18
- 19 Bigg, M.A. 1988. Status of the Steller sea lion, *Eumetopias jubatus*, in Canada. Canadian Field-
- 20 Naturalist 102:315-336.
- 21
- 22 Bograd, S.J., P.J. Stabeno, and J.D. Schumacher. 1994. A census of mesoscale eddies in Shelikof Strait,
- 23 Alaska, during 1991. Geophys. Res. 99:18243-18254.
- 24
- 25 Braham, H.W., R.D. Everitt, B.D. Krogman, D.J. Rugh, and D.E. Withrow. 1977. Marine mammals of
- 26 the Bering Sea: a preliminary report on distribution and abundance, 1975-76. NWAFC
- 27 Processed Report, U.S. Dep. Commer., NOAA, NMFS, NWAFC. National Marine Mammal
- 28 Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115. 90 pp.
- 29
- 30 Braham, H.W., R.D. Everitt, and D.J. Rugh. 1980. Northern sea lion decline in the eastern Aleutian
- 31 Islands. J. of Wildl. Management 44: 25-33.
- 32
- 33 Braham, H.W., G.W. Oliver, C. Fowler, K. Frost, F. Fay, C. Cowles, D. Costa, K. Schneider, and D.
- 34 Calkins. 1982. Marine mammals. Pp. 55-81 in M. J. Hameedi (ed.), The St. George Basin
- 35 Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Alaska
- 36 OCSEAP, Juneau, Alaska.
- 37
- 38 Braham, H.W., and D.W. Rice. 1984. The right whale, *Balaena glacialis*. Mar. Fish. Rev. 46(4):38-44.
- 39
- 40 Bray, J.R. and J.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin.
- 41 Ecological Monographs 27: 325-
- 42
- 43 Brodeur, R.D., and D.M. Ware. 1992. Interannual and interdecadal changes in zooplankton biomass in
- 44 the subarctic Pacific Ocean. Fish. Oceanogr. 1:32-38.
- 45
- 46 Brodeur, R.D., and C.T. Wilson. 1996. A review of the distribution, ecology, and population dynamics
- 47 of age-0 walleye pollock in the Gulf of Alaska. Fish. Oceanogr. 5:148-166.
- 48
- 49 Brownell Jr., R.L., P.B. Best, and J.H. Prescott (eds.). 1986. Right whales: Past and Present Status.
- 50 Rpts. of the IWC; Special Issue No. 10. Cambridge, England. 286 pp.

- 1 Brueggeman, J.J., G.A. Green, K.C. Balcomb, C.E. Bowlby, R.A. Grotefendt, K.T. Briggs, M.L. Bonnell,
2 R.G. Ford, D.H. Varoujean, D. Heinemann, And D.G. Chapman. 1990. Oregon-Washington
3 marine mammal and seabird survey: information synthesis and hypothesis formulation. OCS
4 Study, Minerals Management Survey, Contract 89-0030.
5
- 6 Brueggeman, J.J., et al. 1987. Aerial surveys of endangered cetaceans and other marine mammals in the
7 northwestern Gulf of Alaska and southeastern Bering Sea. Envirosphere Co., Bellevue,
8 Washington. Report to Mineral Management Service, Alaska OCS Office OCSEAP Unit 673 for
9 Contract No. 85-ABC-00093. 72 pp.
- 10
- 11 Buckland, S.T., D.R. Anderson, K.P. Burnham, and J.L. Laake. 1993. Distance Sampling: Estimating
12 abundance of biological populations. Chapman & Hall, London, England, 446 pp.
13
- 14 Bulatov, O.A. 1983. Distribution of eggs and larvae of Greenland halibut, *Reinhardtius hippoglossoides*
15 (Pleuronectidae) in the eastern Bering Sea. J. Ichthyol. 23:157-159.
16
- 17 Burgner, R. L. 1991. Life History of Sockeye salmon (*Oncorhynchus nerka*) Pp. 3-117 in C. Groot
18 and L. Margolis, (eds.), Pacific salmon life histories. UBC Press, Vancouver, B.C.
19
- 20 Burgner, R. L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins
21 of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int.
22 North Pac. Fish. Comm. Bull. 51, 92 p.
23
- 24 Burger, C.V., and Wertheimer, A.C. 1995. Pacific salmon in Alaska. In Our living resources: a report
25 to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems,
26 E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac, eds., U.S. Department of the
27 Interior, National Biological Survey, Washington, DC, pp. 343-347.
28
- 29 Burkenroad, M. D. 1948. Fluctuations in abundance of Pacific halibut. Bull. Bingham Oceanogr. Collect.
30 Yale Univ. 11: 81-129.
31
- 32 Burkenroad, M. D. 1950. Population dynamics in a regulated marine fishery. [Book review of W. F.
33 Thompson's (1950) paper "The effect of fishing on stocks of halibut in the Pacific". University of
34 Washington Press.] The Texas Journal of Science, Volume ii, No. 3, pp. 438-441.
35
- 36 Burkenroad, M. D. 1951. Some principles of marine fishery biology. Publication of the Texas Institute of
37 Marine Sciences, Volume 2, No. 1, pp. 177-212.
38
- 39 Burkenroad, M. D. 1953. Theory and practice of marine fishery management. Rapp. P.-v. Reun. Cons.
40 Inter. Explor. Mer 18: 300-310.
41
- 42 Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimation of density from line transect sampling
43 of biological populations. Wildl. Monogr. 72:202.
44
- 45 Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V.
46 Lagomarsino 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and
47 California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWIFSC-27, 261 p.
48
- 49 Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the Aleutian
50 Islands, Alaska after a ban on salmon driftnets. U. S. Fish and Wildlife Service, Alaska Maritime

1 National Wildlife Refuge, Aleutian Islands Unit, PSC 486, Box 5251, FPO AP 96506-5251,
2 Adak Alaska.

3
4 Byrnes, P.E., and W.R. Hood. 1994. First account of Steller sea lion (*Eumetopias jubatus*) predation on
5 a California sea lion (*Zalophus californianus*). *Marine Mammal Science* 10:381-383.

6
7 Bannister, J. L., and E. Mitchell. 1980. North Pacific sperm whale stock identity: distributional
8 evidence from Maury and Townsend charts. *Rep. Int. Whal. Comm. Spec. Iss.* 2:219-223.

9
10 Calambokidis, J., R. Sears, G.H. Steiger, and J. Evenson. 1995. Movement and stock structure of blue
11 whales in the eastern North Pacific. P. 19 *in* Proceedings of the Eleventh Biennial Conference
12 on the Biology of Marine Mammals, Orlando, Florida, 14-18 December 1995 (abstract). Society
13 for Marine Mammalogy, Lawrence, Kansas

14
15 Calambokidis, J., and G.H. Steiger. 1995. Population assessment of humpback and blue whales using
16 photo-identification from 1993 surveys off California. Final contract report to Southwest
17 Fisheries Science Center, P.O. Box 271, La Jolla, CA.

18
19 Calambokidis, J., G.H. Steiger, J.M. Straley, T. Quinn, L.M. Herman, S. Cerchio, D.R. Salden, M.
20 Yamaguchi, F. Sato, J.R. Urban, J. Jacobson, O von Zeigesar, K.C. Balcomb, C.M. Gabriele,
21 M.E. Dahlheim, N. Higashi, S. Uchida, J.K. B. Ford, y. Miyamura, P. Ladrón de Guevara, S.A.
22 Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of
23 humpback whales in the North Pacific basin. Final Contract Report 50ABNF500113 to
24 Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 72 pp.

25
26 Calkins, D.G. 1985. Steller sea lion entanglement in marine debris. Proceedings of the workshop on the
27 fate and impact of marine debris, 26-29 November 1985, Honolulu, HI. U.S. Dep. Commer.,
28 NOAA Tech. Memo. NMFS-SWFC-54.

29
30 Calkins, D.G. 1987. Marine Mammals. *In* The Gulf of Alaska: physical environment and biological
31 resources. D. W. Hood, S. T. Zimmerman (eds.), pp. 527-560. Alaska Office, Ocean
32 Assessments Division, National Oceanic and Atmospheric Administration, U.S. Dep. of
33 Commer., and the Alaska OCS Region Office, Minerals Management Service, U.S. Department
34 of the Interior. Washington, DC.

35
36 Calkins, D.G., E.F. Becker, and K.W. Pitcher. 1998. Reduced body size of female Steller sea lions from
37 a declining population in the Gulf of Alaska. *Mar. Mamm. Sci.* 14:232-244.

38
39 Calkins, D.G., E.F. Becker, T.R. Spraker, and T.R. Loughlin. 1994. Impacts on Steller sea lions. Pp.
40 119-139 *in* T.R. Loughlin (ed.), *Marine mammals and the Exxon Valdez*. Academic Press, San
41 Diego, CA.

42
43 Calkins, D.G., and E. Goodwin. 1988. Investigation of the declining sea lion population in the Gulf of
44 Alaska. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518, 76
45 pp.

46
47 Calkins, D.G., and K.W. Pitcher. 1982. Population assessment, ecology and trophic relationships of
48 Steller sea lions in the Gulf of Alaska. U.S. Dep. of Commer., NOAA. OCSEAP Final Report
49 19 (1983), pp. 445-546.

- 1 Canino, M.F. 1994. Effects of temperature and food availability on growth and RNA/DNA ratios of
2 walleye pollock, *Theragra chalcogramma* (Pallas), eggs and larvae. J. Exp. Mar. Biol. Ecol.
3 175:1-16.
4
- 5 Carlson, H.R. 1995. Consistent yearly appearance of age-0 walleye pollock, *Theragra chalcogramma*, at
6 a coastal site in southeastern Alaska, 1973-1994. Fish. Bull. 93:386-390.
7
- 8 Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in
9 rocky coastal areas of Southeastern Alaska. Marine Fisheries Review. 43:13-19.
10
- 11 Carretta, J. V., and K. A. Forney. 1993. Report on two aerial surveys for marine mammals in
12 California coastal waters utilizing a NOAA DeHavilland Twin Otter aircraft: March 9- April 7,
13 1991 and February 8-April 6, 1992. NOAA Tech. Memo. NMFS-SWFSC-185. 77 p.
14
- 15 Cetacean and Turtle Assessment Program (CeTAP). 1982. A characterization of marine mammals and
16 turtles in the mid- and North Atlantic shelf areas of the U.S. outer continental shelf. Final Report
17 to the Bureau of Land Management, December 1982, University of Rhode Island, Kingston,
18 Rhode Island. 449 pp.
19
- 20 Chan, E.H., and H.C. Liew. 1989. The leatherback turtle: a Malaysian heritage. Tropical Press Sdn
21 Bhd, Kuala Lumpur, Malaysia. 49 pp.
22
- 23 Cherfas, J. 1989. The Hunting of the Whale. Viking Penguin Inc., New York, New York. 248 p.
24
- 25 Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish
26 Program at the Pacific Biological Station. Canada Spec. Pub. Fish. Aquat. Sci. 60:102.
27
- 28 Chittleborough, R.G. 1965. Dynamics of two populations of humpback whale, *Megaptera Novaeangliae*
29 (Borowski). Aust. J. Mar. Freshwater Res. 16:33-128.
30
- 31 Christensen, I., T. Haug, and N. Øien. 1992. A review of feeding and reproduction in large baleen
32 whales (Mysticeti) and sperm whales *Physeter macrocephalus* in Norwegian and adjacent
33 waters. Fauna norvegica Series A 13:39-48.
34
- 35 Chumbley, K.J. Sease, M. Strick, and R. Towell. 1997. Field studies of Steller sea lions (*Eumetopias*
36 *jubatus*) at Marmot Island, Alaska 1979 through 1994. NOAA Tech. Mem. NMFS-AFSC-77.
37
- 38 Clapham, P. J., L. S. Baraff, C. A. Carlson, M. A. Christian, D. K. Mattila, C. A. Mayo, M. A.
39 Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales,
40 *Megaptera novaeangliae*, in the southern Gulf of Maine. Can. J. Zool. 71:440-443.
41
- 42 Clapham, P.J., and R.L. Brownell, Jr. 1996. Potential for interspecific competition in baleen whales.
43 Rep. Int. Whal. Comm. 46:361-367.
44
- 45 Clapham, P.J., and C.A. Mayo. 1987. Reproduction and recruitment of individually identified
46 humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. Can. J.
47 Zool. 65(12):2853-2863.
48
- 49 Clark, W.G. 1991. Groundfish exploitation rates based on life history parameters. Canadian J. Fish.
50 Aquat. Sci. 48:734-750.

- 1 Clark, W.G. 1993. The effect of recruitment variability on the choice of a target level of spawning
2 biomass per recruit. Pp. 233-246 in G. Kruse, D.M. Eggers, R.J. Marasco, C. Pautzke, T.J.
3 Quinn, II, (eds.), Proceedings of the International Symposium on Management Strategies for
4 Exploited Fish Populations. University of Alaska, Fairbanks, Fairbanks, AK 99775. Alaska Sea
5 Grant Program Report No. 93-02.
6
- 7 Clausen, D.M. 1983. Food of walleye pollock, *Theragra chalcogramma*, in an embayment of
8 southeastern Alaska. Fish. Bull. 81:637-642.
9
- 10 Clausen, D.M., and J. Heifetz. 1999. Pelagic shelf rockfish. In Stock Assessment and Fishery
11 Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska Plan
12 Team, pp. 405-426. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
13 Anchorage, AK 99501)
14
- 15 Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999.
16 Status of chinook salmon and their habitat in Puget Sound. Volume 2, Final Report. June 1999.
17
- 18 Crawford, T.W. 1981. Ph.D. University of Michigan, Ann Arbor, MI.
19
- 20 Daily, M.D. 1975. The distribution and intraspecific variation of helminth parasites in pinnipeds. Rapp.
21 P.-v. Réun. Cons. Int. Explor. Mer 169:338-347.
22
- 23 Daily, M.D., and R.L. Brownell. 1972. A checklist of marine mammal parasites. Pp. 528-589 in S.H.
24 Ridgway (ed.), Mammals of the sea: biology and medicine. Charles C. Thomas, Springfield, Ill.
25
- 26 Dahlheim, M. E., and C. O. Matkin. 1994. Assessment of injuries to Prince William Sound killer
27 whales. Pp 163-171, in T. R. Loughlin (ed.), Marine mammals and the *Exxon Valdez*. Academic
28 Press, San Diego, CA.
29
- 30 Decker, M.B., G.L. Hunt, Jr., and G.V. Byrd, Jr. 1995. The relationships among sea-surface
31 temperature, the abundance of juvenile walleye pollock (*Theragra chalcogramma*), and the
32 reproductive performance and diets of seabirds at the Pribilof Islands, southeastern Bering Sea..
33 Pp. 425-437 in R.J. Beamish (ed.), Climate change and northern fish populations. Can. Spec.
34 Publ. Fish. Aquat. Sci. 121.
35
- 36 DeGange, A.R., and G.A. Sanger. 1986. Marine Birds. Pp. 479-524 in The Gulf of Alaska: Physical
37 environment and biological resources. D. W. Hood, S. T. Zimmerman (eds.), U.S. National
38 Oceanic and Atmospheric Administration, Ocean Assessments Division, Anchorage, Alaska.
39
- 40 de Groot, S.J. 1970. Some notes on the ambivalent behavior of the Greenland halibut, *Rheinhardtius*
41 *hippoglossoides* (Walb.) Pisces: Pleuronectiformes. J. Fish. Biol. 2:275-279.
42
- 43 Deriso, R.B. 1982. Relationship of fishing mortality to natural mortality and growth at the level of
44 maximum sustainable yield. Canadian J. Fish. Aquat. Sci. 39:1054-1058.
45
- 46 Dieterich, R.A. 1981. Alaskan wildlife diseases. Univ. Alaska, Fairbanks.
47
- 48 Donovan, G. P. 1984. Blue whales off Peru, December 1982, with special reference to pygmy blue
49 whales. Rep. Int. Whal. Comm. 34: 473-476.
50

- 1 Donovan, G.P. 1991. A review of IWC stock boundaries. Rep. Int. Whal. Comm., Special Issue 13:39-
2 68.
3
- 4 Dorn, M.W., A. B. Hollowed, E. Brown, B. Megrey, C. Wilson, and J. Blackburn. 1999. Walleye
5 pollock. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of
6 the Gulf of Alaska. Gulf of Alaska Plan Team, pp. 35-104. (North Pacific Fishery Management
7 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
8
- 9 Dwyer, D.A. 1984. M.S. thesis. University of Washington. 102 pp.
10
- 11 Dwyer, D.A., Bailey, K. M., and Livingston, P. A. 1987. Feeding habits and daily ration of walleye
12 pollock (*Theragra chalcogramma*) in the eastern Bering Sea, with special reference to
13 cannibalism. Can. J. Fish. Aquat. Sci. 44:1972-1984.
14
- 15 D'yakov, Y.P. 1982. The fecundity of the Greenland halibut *Reinhardtius hippoglossoides*
16 (Pleuronectidae), from the Bering Sea. J. Ichthyol. 22:59-64.
17
- 18 Ebbesmeyer, C.C., D.R. Cayan, D.R. McLain, F.H. Nichols, D.H. Person, and K.T. Redmond. 1991.
19 1976 Step in the Pacific climate: Forty environmental changes between 1968-1975 and 1977-
20 1984. Proceedings of the Seventh Annual Pacific Climate (PACCLIM) Workshop, April, 1990,
21 California Dept. of Water Resources, Interagency Ecological Studies Program Technical Report
22 26.
23
- 24 Ernst, C.H. and R. W. Barbour. 1989. Turtles of the World. Smithsonian Inst. Press, Washington, D.C.
25 313 pp.
26
- 27 Eschmeyer, W.N., E.S. Herald, H. Hammann, and K.P. Smith. 1984. A field guide to Pacific coast
28 fishes of North America from the Gulf of Alaska to Baja California. Houghton-Mifflin, Boston,
29 336 pp.
30
- 31 Estes, J.A., M.T. Tinker, T.M. Williams and D.F. Doa. 1998. Killer whale predation on sea otters
32 linking oceanic and nearshore ecosystems. Sci. 282: 473-476.
33
- 34 Forest Ecosystem Management Assessment Team [FEMAT]. 1993. Forest ecosystem management: an
35 ecological, economic, and social assessment. U.S. Departments of Agriculture, Commerce,
36 Interior; and the Environmental Protection Agency;; Washington, D.C.
37
- 38 Fadely, B.S., J.A. Zeligs, and D.P. Costa. 1994. Assimilation efficiencies and maintenance requirements
39 of California sea lions (*Zalophus californianus*) fed walleye pollock (*Theragra chalcogramma*)
40 and herring (*Clupea harengus*). Final Report to the National Marine Mammal Laboratory,
41 Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE,
42 Seattle, WA 98115-0070.
43
- 44 Fay, F.H., R.A. Dieterich, L.M. Shults, and B.P. Kelly. 1978. Morbidity and mortality of marine
45 mammals. U.S. Dep. Commer., NOAA, OCSEAP Environ. Assess. Alaska Continental Shelf,
46 Annual Rep. Year ending March 1978, 1:39-79.
47
- 48 Ferrero, R.C. and L.W. Fritz. 1994. Comparisons of walleye pollock, *Theragra chalcogramma*, harvest to
49 Steller sea lion, *Eumetopias jubatus*, abundance in the Bering Sea and Gulf of Alaska. U.S. Dep.
50 of Commer., NOAA Tech. Memo. NMFS-AFSC-43.

- 1 Ferrero, R.C., D.P. DeMaster, P.S. Hill and M. Muto. 2000. Draft Alaska marine mammal stock
2 assessments. National Marine Mammal Laboratory, Seattle, WA.
3
- 4 Fiscus, C.H., and G.A. Baines. 1966. Food and feeding behavior of Steller and California sea lions. *J.*
5 *of Mammal.* 47:195-200.
6
- 7 Forney, K.A., and R.L. Brownell, Jr. 1996. Preliminary report of the 1994 Aleutian Island marine
8 mammal survey. paper SC/48/011 presented to the IWC Scientific Committee, June 1996
9 (unpublished). Available SW Fisheries Science Center, La Jolla, CA.
10
- 11 Forney, K.A., and R.L. Brownell, Jr. 1997. Preliminary report of the 1994 Aleutian Island marine
12 mammal survey. paper SC/48/011 presented to the IWC Scientific Committee, June 1996
13 (unpublished). Available SW Fisheries Science Center, La Jolla, CA.
14
- 15 Forrester, C.R. 1964. Demersal quality of fertilized eggs of rock sole (*Lepidopsetta bilineata* Ayres). *J.*
16 *Fish. Res. Board Canada* 21:1531-1532.
17
- 18 Fournier, D.A. 1998. an introduction to AD Model builder for use in nonlinear modeling and statistics.
19 Otter Research Ltd., P.O. Box 2040, Sidney BC V8L3S3, Canada, 53 p.
20
- 21 Francis, R.C., and S.R. Hare. 1994. Decadal scale regime shifts in the large marine ecosystem of the
22 northeast Pacific: A case for historical science. *Fish. Oceanogr.* 3:279-291.
23
- 24 Fretwell, S.D. 1972. Populations in a seasonal environment. Monographs in Population Biology No. 5.
25 Princeton University Press; Princeton, New Jersey.
26
- 27 Fritz, L.W. 1993. Trawl locations of walleye pollock and Atka mackerel fisheries in the Bering Sea,
28 Aleutian Islands, and Gulf of Alaska. *AFSC Proc. Rep.* 93-08.
29
- 30 Fritz, L.W. 1999. Squid and other species. *In* Stock Assessment and Fishery Evaluation Report for the
31 Groundfish Resources of the Bering Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands
32 Plan Team, pp. 639-654. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite
33 306, Anchorage, AK 99501)
34
- 35 Fritz, L.W. Do trawl fisheries off Alaska create localized depletions of Atka mackerel (*Pleurogrammus*
36 *monopterygius*)? Unpubl. manuscr.
37
- 38 Fritz, L., and R. Ferrero. 1998. Options in Steller sea lion recovery and groundfish fishery management.
39 *Biosph. Conserv.* 1:7-20.
40
- 41 Fritz, L.W., R.C. Ferrero, and R.J. Berg. 1995. The threatened status of Steller sea lions, *Eumetopias*
42 *jubatus*, under the Endangered Species Act: Effects on Alaska Groundfish Fisheries
43 Management. *Mar. Fish. Rev.* 57:14-27.
44
- 45 Fritz, L.W., A. Greig, and R.F. Reuter. 1998. Catch-per-unit-effort, length, and depth distributions of
46 major groundfish and bycatch species in the Bering Sea, Aleutian Islands, and Gulf of Alaska
47 regions based on groundfish fishery observer data. U.S. Dep. Commer., NOAA Tech. Memo.
48 NMFS-AFSC-88.
49
- 50 Frost, K.J., and L.F. Lowry. 1986. Sizes of walleye pollock, *Theragra chalcogramma*, consumed by
November 30, 2000

- 1 marine mammals in the Bering Sea. Fish. Bull. 84:192-197.
- 2
- 3 Furness, R.W. 1982. Competition between fisheries and seabird communities. Pages 225-307. In: J.H.S.
- 4 Blaxter, F.S. Russell, and M. Yonge (eds.) Advances in Marine Biology, Volume 20. Academic
- 5 Press, Inc; New York, New York.
- 6
- 7 Furness, R.W. 1984. Modelling relationships among fisheries, seabirds, and marine mammals. Pages
- 8 117-126. In: D.N. Nettleship, G.A. Sanger, and P.F. Springer (eds.) Marine birds: their feeding
- 9 ecology and commercial fisheries relationships. Canadian Wildlife Service; Ottawa, Canada.
- 10
- 11 Furness, R.W. 1984. Seabird-fisheries relationships in the northeast Atlantic and North Sea. Pages 162-
- 12 169. In: D.N. Nettleship, G.A. Sanger, and P.F. Springer (eds.) Marine birds: their feeding
- 13 ecology and commercial fisheries relationships. Canadian Wildlife Service; Ottawa, Canada.
- 14
- 15 Gambell, R. 1976. World whale stocks. Mammal Rev. 6 (1):41-53.
- 16
- 17 Gambell, R. 1985a. Sei whale *Balaenoptera borealis* Lesson, 1828. Pp. 155-170 in S.H. Ridgway and
- 18 R. Harrison (eds.), Handbook of Marine Mammals, Vol. 3. Academic Press, London.
- 19
- 20 Gambell, R. 1985b. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). pp. 171-192 in S.H. Ridgway
- 21 and R. Harrison (eds.), Handbook of marine mammals, Vol. 3 Academic Press, London.
- 22
- 23 Gaichas, S., L.W. Fritz, and J.N. Ianelli. 1999. Other species considerations for the Gulf of Alaska. In
- 24 Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of
- 25 Alaska. Gulf of Alaska Plan Team, pp. 621-662. (North Pacific Fishery Management Council,
- 26 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 27
- 28 Gendron, D. and R. Sears. 1993. Blue whales and *Nyctiphanes simplex* surface swarms: a close
- 29 relationship in the southwest Gulf of California, Mexico. Pp 52 In Proceedings of the 10th
- 30 Biennial Conf on Marine Mammal Biology, Galveston, Texas, December 1993.
- 31
- 32 Gendron, D. and V. Zavala-Hernandez. 1995. Blue whales of Baja California: a summary of their
- 33 distribution and preliminary reproductive data based on photoidentification. Pp 43 In
- 34 Proceedings of the 11th Biennial Conference on the Biology of Marine Mammals, Orlando,
- 35 Florida, December 1995.
- 36
- 37 Gentry, R.L. 1970. Social behavior of the Steller sea lion. Ph.D. thesis, Univ. California, Santa Cruz.
- 38 113 pp.
- 39
- 40 Gentry, R.L., J.H. Johnson. 1981. Predation by sea lions on northern fur seal neonates. Mammal.
- 41 45(4):423-430
- 42
- 43 Geraci, J.B. 1979. The role of parasites in marine mammal strandings along the New England coast. Pp.
- 44 85-90 in J.B. Geraci and D.J. St. Aubin (eds.), Biology of marine mammals: insights through
- 45 strandings. Marine Mammal Commission, Washington, D.C.
- 46
- 47 Gilbert, C.H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish
- 48 Comm. 32:57-70.
- 49
- 50 Gilpatrick, J., W. Perryman, L. Lynn, and M.A. DeAngelis. 1997. Geographic populations of blue

1 whales (*Balaenoptera musculus*) in the North Pacific Ocean investigated from whaling records
2 and aerial photogrammetry. Paper SC/47/NP4 presented to the IWC Scientific Committee, May
3 1995 (unpublished). Available SW Fisheries Science Center, La Jolla, CA.

4
5 Gilpin, M.E., and M.E. Soulé. 1986. Minimum viable populations: processes of species extinction. Pp.
6 19-34 in Conservation biology: the science of scarcity and diversity, M.E. Soulé (ed.), Sinauer
7 Associates, Inc., Sunderland, Massachusetts, 584 pp.

8
9 Goddard, P.C. and D.J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Mar.
10 Mamm. Sci. 14(2):344-349.

11
12 Goodwin E.A., and D.G. Calkins. 1985. Preliminary results of ongoing investigations of San Miguel
13 Sea lion Virus, leptospirosis, and chlamydiosis in Alaska Steller sea lions and their relationship
14 to declining pup counts. Sixth Biennial Conference on the biology of Marine Mammals, 22-26
15 November, Vancouver, B.C. (Abstract).

16
17 Gosh, M.E., D.W. Rice, and J.M. Breiwick. 1984. Sperm whale interactions with longline vessels in
18 Alaska waters during 1997. Unpubl. rep. Available Alaska Fisheries Science Center, 7600 Sand
19 Point Way NE, Seattle, WA 98115.

20
21 Grant, W.S., C.I. Zhang, T. Kobayashi, and G. Stahl. 1987. Lack of genetic stock discretion in Pacific
22 cod (*Gadus macrocephalus*). Canadian J. Fish. Aquat. Sci. 44:490-498.

23
24 Greene, D.H., and J.K. Babbitt. 1990. Control of muscle softening and protease-parasite interactions in
25 arrowtooth flounder, *Atheresthes stomias*. Journal of Food Science 55:579-580.

26
27 Grover, J. J. 1990. Feeding ecology of late-larval and early juvenile walleye pollock (*Theragra*
28 *chalcogramma*) from the Gulf of Alaska in 1987. Fish. Bull. 88:463-470.

29
30 Hagerman, F.B. 1952. The biology of the dover sole, *Microstomus pacificus* (Lockington). Calif. Div.
31 Fish Game Fish. Bull. 78:64.

32
33 Hall, J.D. 1979. A survey of cetaceans of Prince William Sound and adjacent vicinity--their numbers
34 and seasonal movements. Pp. 631-726 in Environmental Assessment of the Alaska Continental
35 Shelf: Final Reports of the Principal Investigators. Biological Studies, Vol. 6. Boulder, NOAA-
36 OCSEAP.

37
38 Hall, J.D. 1982. Prince William Sound, Alaska: Humpback whale population and vessel traffic study.
39 Final report, Contract No. 81-ABG-00265. NMFS, Juneau Management Office, Juneau, Alaska.
40 16 pp.

41
42 Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada Bull. 180, Canadian Government
43 Publishing Centre, Supply and Services Canada, Ottawa, K1A 0S9, 740 pp.

44
45 Hartt, A.C. and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and
46 steelhead trout. International North Pacific Fisheries Commission Bulletin
47 46:1-105. In Nickelson *et al.* (1992a).

48
49 Hartt, A. C., and M. B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and
50 steelhead trout. Int. North Pac. Fish. Comm. Bull. 46:105 p.

- 1 Hatch, S.A., and G.A. Sanger. 1992. Puffins as samplers of juvenile pollock and other forage fish in the
2 Gulf of Alaska. *Mar. Ecol. Prog. Ser.* 80:1-14.
3
- 4 Harvey, J. T., and M. E. Dahlheim. 1994. Cetaceans in oil. *Pp.* 257-264, *in* T. R. Loughlin (ed.),
5 Marine mammals and the *Exxon Valdez*, p. 257-264. Academic Press, San Diego, CA.
6
- 7 Healey, M. C. 1991. Life History of Chinook salmon (*Oncorhynchus tshawytscha*). *Pp.* 313-393 *in* C.
8 Groot and L. Margolis, (eds.), Pacific salmon life histories. UBC Press, Vancouver, B.C.
9
- 10 Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the Gulf of Alaska. National Marine
11 Fisheries Service, Auke Bay Laboratory, 11305 Glacier Hwy, Juneau, AK 99801, unpubl.
12 manuscr., 17 pp.
13
- 14 Heifetz, J., and D.M. Clausen. 1991. Slope rockfish. *Pp.* 362-396 *in* Stock Assessment and Fishery
15 Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska Plan
16 Team (eds.), North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
17 Anchorage, AK 99501 .
18
- 19 Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1997. Slope rockfish. *Pp.* 248-289 *in* Stock Assessment and
20 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for
21 1998. Gulf of Alaska Plan Team (eds.), North Pacific Fishery Management Council, 605 W. 4th
22 Avenue, Suite 306, Anchorage, AK 99501.
23
- 24 Heifetz, J. and J. T. Fujioka. 1991. Movement dynamics of tagged sablefish in the northeastern Pacific.
25 *Fish. Res.* 11: 355-374.
26
- 27 Heifetz, J., J.N. Ianelli, D.M. Clausen, and J. T. Fujioka. 1999. Slope rockfish. *In* Stock Assessment and
28 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska
29 Plan Team, pp. 307-404. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite
30 306, Anchorage, AK 99501)
31
- 32 Herman, L.M. Forestell, P.H., and R.C. Antinaja. 1980. The 1976/1977 migration of humpback whales
33 into Hawaiian waters: composite description. Marine Mammal Commission Report No. MMC
34 77-19. Washington, D.C.
35
- 36 Hermann, A.J., S. Hinckley, B.A. Megrey, and P.J. Stabeno. 1996. Interannual variability of the early
37 life history of walleye pollock near Shelikof Strait as inferred from a spatially explicit, individual
38 - based model. *Fish. Oceanogr.* 5:39-57.
39
- 40 Hilborn, R. and C.J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics and
41 uncertainty. Chapman and Hall, New York, NY. 570 pp.
42
- 43 Hill, B.L. 1968. A survey of parasites of sea lions from Año Nuevo Islands. *Pp.* 39-43 *in* Año Nuevo
44 reports. Vol. 2, 1967-1968. Scientific studies in Año Nuevo State Reserve, California and
45 Related Investigation. Univ. California, Santa Cruz.
46
- 47 Hill, P.S., and D.P. DeMaster. 1998. Draft Alaska marine mammal stock assessments 1998. National
48 Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115-0070.
49
- 50 Hill, P.S., D. P. DeMaster, and R. J. Small. 1997. Alaska stock assessments, 1996. U.S. Dep.

1 Commer., NOAA Tech. Memo. NMFS-AFSC, 150 p.

2
3 Hill, P.S. and D.P. DeMaster. 1999. Alaska marine mammal stock assessments 1998. National Marine
4 Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115-0070.

5
6 Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and
7 Pacific coast regions, 1975-1981. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-44,
8 50 pp.

9
10 Hodge, R. P. 1979. *Dermochelys coriacea schlegeli* (Pacific leatherback), U.S.A. Alaska. Herpetol.
11 Review 10(3): 102.

12
13 Hollowed, A.B., and W.S. Wooster. 1995. Decadal-scale variations in the eastern Subarctic Pacific: II.
14 Response of Northeast Pacific fish stocks. In *Climate Change and Northern Fish Populations*.
15 Can. Spec. Pub. of the Fish. Aquat. Sci. 121:373-385.

16
17 Hollowed, A.B., and W.S. Wooster. 1992. Variability of winter ocean conditions and strong year classes
18 of Northeast Pacific groundfish. *ICES Mar. Sci. Symp.* 195:433-444.

19
20 Hollowed, A. B., E. Brown, J. Ianelli, P. Livingston, B. Megrey, and C. Wilson. 1997. Walleye pollock.
21 North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK
22 99501, pp. 362-396.

23
24 Hollowed, A.B., B.A. Megrey, P. Munro, and W. Karp. 1991. Walleye pollock. *In* Stock Assessment
25 and Fishery Evaluation Report for the 1992 Gulf of Alaska Groundfish Fishery. Gulf of Alaska
26 Plan Team, Ed North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
27 Anchorage, AK 99501.

28
29 Hollowed, A.B., N. Bax, R. J. Beamish, J. Collie, M. Fogarty, P.A. Livingston, J. Pope, and J.C. Rice.
30 2000. Are multispecies models an improvement on single-species models for measuring fishing
31 impacts on marine ecosystems. *ICES J. Marine Sci.* 57: in press.

32
33 Honkalehto, T. 1989. A length-cohort analysis of walleye pollock based on empirical estimation of
34 cannibalism and predation by marine mammals. *Proceedings Intl. Symp. Biol. Management*
35 *Walleye Pollock*, November 1988. University of Alaska, Fairbanks, AK 99775. Alaska Sea
36 Grant Report 89-1. pp. 651-665.

37
38 Hood, D.W. and J.A. Calder (eds). 1981. The eastern Bering Sea shelf: oceanography and resources,
39 Vol. 1 and 2. Office of Marine Pollution Assessment, NOAA and BLM. Univ of Washington
40 Press, Seattle, WA. 1,339 pp

41
42 Hood, D.W. and S. T. Zimmerman (Eds.). 1987. The Gulf of Alaska. Physical environment and its
43 biological resources, U.S. Dep Commerce, NOAA, NOS, Office of Oceanogr and Marine
44 Assess., Ocean Assess. Division, Alaska Office, available NITS, Springfield, VA as PB87-
45 103230. 655 pp.

46
47 Hoover, A.A. 1988. Steller Sea Lion. Pp. 159-193 *in* Selected Marine Mammals of Alaska: Species
48 Accounts with Research and Management Recommendations, J.W. Lentfer (ed.). Marine
49 Mammal Commission, Washington, D.C.

- 1 Horwood, J. 1987. The sei whale: population biology, ecology and management. Croom Helm,
2 Beckenham, Kent, UK.
3
- 4 Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Ormann. 1985. Stock assessment
5 of Columbia River anadromous salmonids. Vol. I. U.S. Dept. of Energy, Bonneville Power
6 Administration. Project No. 83-335. 558p.
7
- 8 Hubbs, C.L., and N.J. Wilimovsky. 1964. Distribution and synonymy in the Pacific Ocean and variation
9 of the Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum). J. Fish. Res. Board
10 Canada. 21:1129-1154.
11
- 12 Hunt, G.L. Jr., B. Burgeson, and G.A. Sanger. 1981. Feeding ecology of seabirds of the eastern Bering
13 Sea. Pp. 629-647 in *The Eastern Bering Sea Shelf: Oceanography and Resources*. D. W. Hood,
14 J. A. Calder (eds.), University of Washington Press. Seattle, WA, vol. 2.
15
- 16 Hunt, G.L. Jr., M.B. Decker, and A. Kitaysky. 1995. Fluctuations in the Bering Sea ecosystem as
17 reflected in the reproductive ecology and diets of kittiwakes on the Pribilof Islands, 1975 to
18 1990. in *Aquatic Predators and their Prey*. S. P. R. Greenstreet, M. L. Tasker (eds.), Blackwell
19 Scientific Publications, Oxford.
20
- 21 Hutchinson, G.E. 1957. Concluding remarks. *Population Studies: Animal Ecology and Demography*.
22 Cold spring Harbor Symposium on Quantitative Biology 22: 415-427.
23
- 24 Ianelli, J.N., L. Fritz, T. Honkalehto, N. Williamson, and G. Walters. 1999. Eastern Bering Sea walleye
25 pollock assessment. In *Stock Assessment and Fishery Evaluation Report for the Groundfish
26 Resources of the Bering Sea/Aleutian Islands Region*. Bering Sea/Aleutian Islands Plan Team,
27 pp. 37-150. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
28 Anchorage, AK 99501)
29
- 30 Ianelli, J.N., and S. Gaichas. 1999. Stock assessment of Gulf of Alaska thornyheads (*Sebastolobus sp.*).
31 In *Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of
32 Alaska*. Gulf of Alaska Plan Team, pp. 467-510. (North Pacific Fishery Management Council,
33 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
34
- 35 Ianelli, J.N., and T.M. Wilderbuer. 1995. Greenland turbot (*Reinhardtius hippoglossoides*) stock
36 assessment and management in the Eastern Bering Sea. in *Proceedings of the International
37 Symposium on North Pacific Flatfish, Alaska Sea Grant Report AK-SG-95-04*, University of
38 Alaska, Fairbanks, Fairbanks, AK 99775. pp. 407-441.
39
- 40 Ianelli, J.N., T.K. Wilderbuer, and T.M. Sample. 1997. Stock assessment of Greenland Turbot. in *Stock
41 Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering
42 Sea/Aleutian Islands Regions*. Bering Sea/Aleutian Islands Plan Team (eds.), North Pacific
43 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501, pp. 188-
44 218.
45
- 46 Imler, R.H., and H.R. Sarber. 1947. Harbor seals and sea lions in Alaska. U.S. Dept. of the Interior,
47 Fish and Wildlife Service, Spec. Sci. Rep. 28, 23 pp.
48
- 49 Ingraham, W. J. Jr., C.C. Ebbesmeyer, and R.A. Hinrichsen. 1998. Imminent Climate and Circulation
50 Shift in Northeast Pacific Ocean Could Have Major Impact on Marine Resources. EOS, Trans.
November 30, 2000

1 Am. Geophys. U.
2

3 International Union for the Conservation of Nature. 1996. 1996 IUCN Red List of threatened animals.
4 IUCN, Gland, Switzerland. 368 p.
5

6 International Whaling Commission (IWC). 1980. Report of the sub-committee on protected species and
7 aboriginal whaling. Rep. Int. Whal. Comm. 30:103-111.
8

9 IWC. 1992 . Report of the Scientific Committee. Annex I. Rep. Int. Whal. Comm. 42:236-239.
10

11 IWC. 1995. Report of the Scientific Committee, Annex E. Rep. Int. Whal. Comm. 45:121- 138.
12

13 Ito, D.H., and P.D. Spencer. 1999. Other rockfish. *In* Stock Assessment and Fishery Evaluation Report
14 for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. Bering Sea/Aleutian
15 Islands Plan Team, pp. 559-568. (North Pacific Fishery Management Council, 605 W. 4th
16 Avenue, Suite 306, Anchorage, AK 99501)
17

18 Ito, D.H., P.D. Spencer, and J.N. Ianelli. 1999. Pacific Ocean Perch. *In* Stock Assessment and Fishery
19 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region.
20 Bering Sea/Aleutian Islands Plan Team, pp. 519-558. (North Pacific Fishery Management
21 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
22

23 Iverson, S.J. 1993. Milk secretion in marine mammals in relation to foraging: can milk fatty acids
24 predict diet? Symp. Zool. Soc. London 66:263-291.
25

26 Iverson, S.J., K.J. Frost, and L.F. Lowry. 1997. Fatty acid signatures reveal fine scale structure of
27 foraging distribution of harbor seals and their prey in Prince William Sound, Alaska. Mar. Ecol.
28 Prog. Series 151:255-271.
29

30 Jameson, R.J., and K.W. Kenyon. 1977. Prey of sea lions in the Rogue River, Oregon. J. Mammal.
31 58:672.
32

33 Jewett, S.C. 1978. Summer food of the Pacific cod, *Gadus macrocephalus*, near Kodiak Island, Alaska.
34 Fish. Bull. 76:700-706.
35

36 Johnson, S.R., J.J. Burns, C.I. Malme, and R.A. Davis. 1989. Synthesis of information on the effects of
37 noise and disturbance on major haulout concentrations of Bering Sea pinnipeds. Rep. to U.S.
38 Minerals Management Service, Anchorage, AK. No. MMS 88-0092.
39

40 Johnson, J.H., and A.A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fish.
41 Rev. 46(4):30-37.
42

43 Jones, R.E. 1981. Food habits of smaller marine mammals from northern California. Proc. Calif. Acad.
44 Sci. 42:409-433.
45

46 Jurasz, C. M. and V. Jurasz. 1979. Feeding modes of the humpback whale, *Megaptera*
47 *novaeangliae*, in southeast Alaska. Sci. Rep. Whales Res. Inst., Tokyo 31:69-83.
48

49 Kajimura, H. 1984. Opportunistic feeding of the northern fur seal, *Callorhinus ursinus*, in the eastern
50 North Pacific Ocean and eastern Bering Sea. U.S. Dep. of Commer., NOAA Tech. Rep. NMFS

1 SSRF-779.

- 2
- 3 Kajimura, H., and C.W. Fowler. 1984. Apex predators in the walleye pollock ecosystem in the eastern
4 Bering Sea and Aleutian Islands regions. Pp. 193-234 *in* Proceedings of the workshop on
5 walleye pollock and its ecosystem in the eastern Bering Sea, D. H. Ito (ed.). U.S. Dep.
6 Commer., NOAA Tech. Memo. NMFS F/NWC-62.
- 7
- 8 Kajimura, H., and T.R. Loughlin. 1988. Marine mammals in the oceanic food web of the eastern
9 subarctic Pacific. Bull. Ocean Res. Inst. 26:187-223.
- 10
- 11 Kastelein, R.A., N. Vaughan, and P.R. Wiepkema. 1990. The food consumption of Steller sea lions
12 (*Eumetopias jubatus*). Aquat. Mamm. 15:13
- 13
- 14 Kasuya, T. 1991. Density dependent growth in North Pacific sperm whales. Mar. Mamm. Sci.
15 7(3):230-257.
- 16
- 17 Kawakami, T. 1980. A review of sperm whale food. Scientific Report of the Whales Research Institute
18 Tokyo 32:199-218.
- 19
- 20 Kawamura, A. 1980. A review of food of balaenopterid whales. Sci. Rep. Whales Res. Inst. 32:155-
21 197.
- 22
- 23 Kawamura, A. 1982. Food habits and prey distributions of three rorqual species in the North Pacific
24 Ocean. Sci. Rep. Whales Res. Inst. 34:59-91.
- 25
- 26 Kendall, A.W.J., M.E. Clarke, M.M. Yoklavich, and G.W. Boehlert. 1987. Distribution, feeding and
27 growth of larval walleye pollock, *Theragra chalcogramma*, from Shelikof Strait, Gulf of Alaska.
28 Fish. Bull. 85:499-521.
- 29
- 30 Kendall, A.W., and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific
31 rockfishes. Proc. of the Internatl. Rockfish Symp., Anchorage, AK, pp. 99-117.
- 32
- 33 Kendall, A.W., Schumacher, J.D., and Kim, S. 1996. Walleye pollock recruitment in Shelikof Strait:
34 Applied fisheries oceanography. Fish. Oceanogr. 5:4-18.
- 35
- 36 Kenyon, K.W. 1962. History of the Steller sea lion at the Pribilof Islands, Alaska. J. Mammal. 43:68-75.
- 37
- 38 Kenyon, K.W., and D.W. Rice. 1961. Abundance and distribution of the Steller sea lion. J. of Mammal.
39 42:223-234.
- 40
- 41 Kenyon, K.W., V.B. Scheffer, D.G. Chapman. 1954. A population study of the Alaska fur-seal herd.
42 Special Scientific Report- Wildlife No. 12.)
- 43
- 44 Ketchen, K.S. 1964. Preliminary results of studies on a growth and mortality of Pacific cod (*Gadus*
45 *macrocephalus*) in Hecate Strait, British Columbia. J. Fish. Res. Board Canada 21:1051-1067.
- 46
- 47 Kimura, D.K. and L.L. Ronholt. 1988. Atka mackerel. Pp. 147-171 *in* R. Bakkala (ed.), Condition of
48 groundfish resources of the eastern Bering Sea and Aleutian Islands region in 1987. U.S. Dep.
49 Commer., NOAA Tech. Memo. NMFS F/NWC-139.

- 1 Klumov, S.K. 1962. The right whales in the Pacific Ocean. *In* P.I. Usachev (ed.), Biological Marine
2 Studies. Trudy Inst. Okeanogr. 58:202-297.
3
- 4 Knechtel, C.D., and L.J. Bledsoe. 1983. A numerical simulation model of the population dynamics of
5 walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem: Part II,
6 Model calibration, validation, and exercise. U.S. Dep. of Commer., NOAA Tech. Memo. NMFS
7 F/NWC-50. 264 pp.
8
- 9 Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oreg. Dep. Fish Wildl. Rep.,
10 217p. + app.
11
- 12 Krahn, M.M. 1997. Letter and table reporting results of chlorinated hydrocarbon analyses from blubber
13 samples of adult, female Steller sea lions from southeast Alaska. *In* K. Pitcher (ed.), Steller sea
14 lion recovery investigations in Alaska, 1996-1997. Alaska Department of Fish and Game
15 Contract Report: 125 pp.
16
- 17 Kramer, D.E., and V.M. O'Connell, V. M. 1988. Guide to Northeast Pacific Rockfishes: Genera
18 *Sebastes* and *Sebastolobus*. Alaska Sea Grant Advisory Bulletin 25.
19
- 20 Krebs, C.J. 1985. Ecology: The experimental analysis of distribution and abundance. Harper & Row,
21 Publishers, New York, 800 pp.
22
- 23 Krieger, K.J. 1985. Food habits and distribution of first-year walleye pollock, *Theragra chalcogramma*
24 (Pallas), in Auke Bay, Southeastern Alaska. M.S. Thesis. University of Alaska Southeast, 11120
25 Glacier Highway, Juneau, AK 99801. 57 pp.
26
- 27 Krieger, K. J. and B. L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale
28 movements. NOAA Tech. Memo. NMFS F/NWC-98. U.S. Natl. Mar. Fish. Serv., Auke
29 Bay, AK. NTIS PB86-204054, 62 p.
30
- 31 Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by
32 bottom trawling. Fishery Bulletin. 91:87-96.
33
- 34 Krieger, K.J. 1997. Sablefish, *Anoplopoma fimbria*, observed from a manned submersible. *in* Biology
35 and Management of Sablefish, *Anoplopoma fimbria*, M. E. Wilkins, M. W. Saunders, Eds.,
36 NOAA Technical Report NMFS 130 U.S. Department of Commerce, NOAA.
37
- 38 Krone, C. 1997. Letter and tables reporting results of contaminant analyses of tissues from Steller sea
39 lions sampled at the Pribilof Islands, Alaska. (C. Krone, NWFSC, 2725 Montlake Boulevard
40 East, Seattle, WA 98112).
41
- 42 Laevastu, T. and F. Favorite. 1988. Fishing and stock fluctuations. Fishing News Books Ltd., Farnham,
43 Surrey, England. 239 pp.
44
- 45 Laidig, T.E., P.B. Adams, and W.M. Samiere. 1997. Feeding habits of sablefish, *Anoplopoma fimbria*,
46 off the coast of Oregon and California. *in* Biology and Management of Sablefish, *Anoplopoma*
47 *fimbria*, M. E. Wilkins, M. W. Saunders (eds.). U.S. Dep. Commer., NOAA Tech. Rep. NMFS
48 130.
49
- 50 Lambertsen, R. H. 1992. Crassicaudosis: a parasitic disease threatening the health and population

- 1 recovery of large baleen whales. Rev. sci. tech. Off. int. Epiz. 11(4):1131-1141.
- 2
- 3 Lambertsen, R. H. B. A. Kohn, J. P. Sundberg, and C. D. Buergelt. 1987. Genital papillomatosis in
4 sperm whale bulls. J. Wildlife Diseases. 23(3):361-367.
- 5
- 6 Lang, G.M., and P.A. Livingston. 1996. Food habits of key groundfish species in the eastern Bering Sea
7 slope region. U.S. Dep. of Commer., NOAA Tech. Mem. NMFS-AFSC-297. 110 pp.
- 8
- 9 Leatherwood, S., A.E. Bowles, and R.R. Reeves. 1983. Aerial surveys of marine mammals in the
10 southeastern Bering Sea. U.S. Dep. Commer., NOAA OCS Environmental Assessment Program.
11 Final Report 42:147-490.
- 12
- 13 Leatherwood, S., A.E. Bowles, and R.R. Reeves. 1986. Aerial surveys of marine mammals in the
14 southeastern Bering Sea. U.S. Dep. Commer., NOAA, OCSEAP Final report 42 (1986):147-490.
- 15
- 16 Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, dolphins, and porpoises of
17 the eastern North Pacific and adjacent arctic waters: a guide to their identification. NOAA Tech.
18 Rep. NMFS Circ. 444.
- 19
- 20 Lee, J.S., S. Tanabe, H. Umino, R. Tatsukawa, T.R. Loughlin, and D.C. Calkins. 1996. Persistent
21 organochlorines in Steller sea lion (*Eumetopias jubatus*) from the bulk of Alaska and the Bering
22 Sea, 1976-1981. Mar. Poll. Bull. 32:535-544.
- 23
- 24 Levings, C.S.M. 1968. Fertilized eggs of the butter sole, *Isopsetta isolepis*, in Skidegate Inlet, British
25 Columbia. J. Fish. Res. Board Canada. 25:1743-1744.
- 26
- 27 Livingston, P.A. 1985. Summer food habits of young-of-the-year walleye pollock, *Theragra*
28 *chalcogramma*, in the Kodiak area of the Gulf of Alaska during 1985. AFSC, 7600 Sand Point
29 Way NE, Seattle, WA 98115. Unpubl. manuscr.
- 30
- 31 Livingston, P.A. 1989a. Key fish species, northern fur seals (*Callorhinus ursinus*), and fisheries
32 interactions involving walleye pollock (*Theragra chalcogramma*), in the eastern Bering Sea. J.
33 Fish. Biol. 35:179-186.
- 34
- 35 Livingston, P.A. 1989b. Interannual trends in walleye pollock, *Theragra chalcogramma*, cannibalism in
36 the eastern Bering Sea. Pp 275-296 in Proceedings of the International Symposium Biol.
37 Management Walleye Pollock, November 1988. Alaska Sea Grant Report 89-1.
- 38
- 39 Livingston, P.A. 1991a. Total groundfish consumption of commercially important prey. U.S. Dep.
40 Commer., NOAA Tech. Memo. NMFS F/NWC-207. 240 pp.
- 41
- 42 Livingston, P.A. 1991b. Groundfish food habits and predation on commercially important prey species
43 in the Eastern Bering Sea from 1984-1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS
44 F/NWC-207. 240 pp.
- 45
- 46 Livingston, P.A. 1993. Importance of predation by groundfish, marine mammals and birds on walleye
47 pollock and Pacific herring in the eastern Bering Sea. Marine Ecology Prog. Ser. 102:205-215.
- 48
- 49 Livingston, P.A. 1994. Overview of multispecies interactions involving walleye pollock in the eastern
50 Bering Sea and Gulf of Alaska. Draft manuscr.

- 1 Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially
2 important prey species in the eastern Bering Sea from 1990 to 1992. AFSC Processed Report 96-
3 04. 214 pp.
4
- 5 Livingston, P.A., and G.M. Lang. 1997. Interdecadal comparisons of walleye pollock cannibalism in the
6 eastern Bering Sea. in Ecology of Juvenile Walleye Pollock. R.D. Brodeur, P.A. Livingston, A.
7 Hollowed, T. Loughlin (eds.), pp. 115-124. U.S. Dep. Commer., NOAA.
8
- 9 Livingston, P.A. and R.D. Methot. 1998. Incorporation of predation into a population assessment
10 model of eastern Bering Sea walleye pollock. Pp. 663-678 In fishery Stock Assessment Models,
11 Alaska Sea Grant College, Publ AK-SC-98-01. 1037 pp.
12
- 13 Livingston, P.A. and Jurado-Molina, J. 1999. A multispecies virtual population analysis of the eastern
14 Bering Sea. ICES J. Mar Sci. 57: 264-269.
15
- 16 Livingston, P.A., D.A. Dwyer, D.L. Wencker, M.S. Yang, and G.M. Yang. 1986. Trophic interactions of
17 key fish species in the eastern Bering Sea. Symposium on biological interactions in the North
18 Pacific region and on factors affecting recruitment, distribution, and abundance of non-
19 anadromous species. International North Pacific Fisheries Commission. INPFC Bull. 47:49-65.
20
- 21 Livingston, P.A., A. Ward, G.M. Lang, and M.S. Yang. 1993. Groundfish food habits and predation on
22 commercially important prey species in the eastern Bering Sea from 1987 to 1989. U.S. Dep.
23 Commer., NOAA Tech. Memo. NMFS-AFSC-11, 192 pp.
24
- 25 Livingston, P.A., L-L Low, and R. J. Murasco. 1999. Eastern Bering Sea ecosystem trends. Pp 140-162
26 In Sherman, K. and Q. Targe (Eds.), Large marine ecosystems of the Pacific rim: assessment,
27 sustainability and management. Blackwell Science, Malden, Mass. 465 pp.
28
- 29 Loughlin, T.R. 1987. Report of the workshop on the status of the northern sea lion in Alaska. Proc.
30 Rep. NWAFC/NMFS/NOAA.
31
- 32 Loughlin, T.R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Molecular
33 Genetics of Marine Mammals, Spec. Pub. 3:159-171.
34
- 35 Loughlin, T.R. 1998. The Steller sea lion: a declining species. Biosphere Conserv. 1: 91-98..
36
- 37 Loughlin, T.R., P.J. Gearin, R.L. DeLong, and R.L. Merrick. 1986. Assessment of net entanglement on
38 northern sea lions in the Aleutian Islands, 25 June-15 July 1985. NWAFC Proc. Rep. 86-02, 50
39 pp.
40
- 41 Loughlin, T.R. and R.L. Merrick. 1989. Comparison of commercial harvest of walleye pollock and
42 northern sea lion abundance in the Bering Sea and Gulf of Alaska. Proceedings of the
43 International Symposium on the Biological Management of Walleye Pollock.
44
- 45 Loughlin, T., and Nelson Jr., R. 1986. Incidental mortality of northern sea lions in Shelikof Strait,
46 Alaska. Mar. Mamm. Sci. 2:14-33.
47
- 48 Loughlin, T.R., and M.A. Perez. 1985. *Mesoplodon stejnegeri*. Mammalian Species. 250.
49
- 50 Loughlin, T.R., M.A. Perez, R.L. Merrick. 1987. *Eumetopias jubatus*. Mammalian Species 283:1-7.

- 1 Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. *In* Stock assessment and fishery evaluation report for
2 the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery
3 Management Council. 605 West 4th Ave., Suite 306, Anchorage, Alaska 99510.
4
- 5 Lowe, S.A., and L.W. Fritz. 1997. Atka mackerel. *In* Stock assessment and fishery evaluation report for
6 groundfish resources in the Bering Sea/Aleutian Islands Region as projected for 1998. North
7 Pacific Fishery Management Council. 605 W. 4th Ave., Suite 306, Anchorage, AK.
8
- 9 Lowe, S.A., D.M. Van Doornik, and G.A. Winans. 1998. Geographic variation in genetic and growth
10 patterns of Atka mackerel, *Pleurogrammus monoptygius* (Hexagrammidae), in the Aleutian
11 archipelago. *Fish. Bull. U.S.* 96:502-515.
12
- 13 Lowe, S.A., and L.W. Fritz. 1999. Assessment of Bering Sea/Aleutian Islands Atka mackerel. *In* Stock
14 Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering
15 Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team, pp. 569-638. (North
16 Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
17
- 18 Lowe, S.A. and L.W. Fritz. 1999a. Atka Mackerel. Stock assessment and fishery. Pp. 569-638 in
19 Evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands as projected for
20 2000, Bering Sea and Aleutian Islands Plan Team, ed., NPFMC, Anchorage, Alaska.
21
- 22 Lowe, S.A. and L.W. Fritz. 1999b. Atka Mackerel. Stock assessment and fishery. Pp. 569-638 in
23 Evaluation report for the groundfish resources of the Gulf of Alaska as projected for 2000,
24 Bering Sea and Aleutian Islands Plan Team, ed., NPFMC, Anchorage, Alaska.
25
- 26 Lowry, L.F., K.J. Frost, D.G. Calkins, G.L. Swartzman, and S. Hills. 1982. Feeding habits, food
27 requirements, and status of Bering Sea marine mammals. Final report to the North Pacific
28 Fishery Management Council, P.O. Box 3136 DT, Anchorage, Alaska 99510. Contract No. 81-4.
29
- 30 Lowry, L.F., V.N. Burkanov, and K.J. Frost. 1997. Importance of walleye pollock in the diet of phocid
31 seals in the Bering Sea and northwestern Pacific Ocean. *U.S. Dep. Commer., NOAA Tech.0*
32 *Rep.* 126.
33
- 34 Lowry, L.F., K.J. Frost, D.G. Calkins, G.L. Swartzman, and S. Hills. 1982. Feeding habits, food
35 requirements, and status of Bering Sea marine mammals. Final report to the North Pacific
36 Fishery Management Council, P.O. Box 3136 DT, Anchorage, Alaska 99510. Contract No. 81-4.
37
- 38 Lowry, L.F., K.J. Frost, and T.R. Loughlin. 1989. Importance of walleye pollock in the diets of marine
39 mammals in the Gulf of Alaska and Bering Sea, and implications for fishery management.
40 Alaska Sea Grant Report AK-SG-89-01. Pp. 701-726.
41
- 42 Mace, P.M. 1994. Relationships between common biological reference points used as thresholds and
43 targets of fisheries management strategies. *Canadian Journal of Fisheries and Aquatic Sciences*
44 51:110-122.
45
- 46 Mackintosh, N. A. 1942. The southern stocks of whalebone whales. *Discovery Rep.* 22:197-300.
47
- 48 Maloney, N.E., and J. Heifetz. 1997. Movements of tagged sablefish, *Anoplopoma fimbria*, released in
49 the eastern Gulf of Alaska. *In* Biology and Management of Sablefish, *Anoplopoma fimbria*, M.
50 E. Wilkins, M. W. Saunders (eds.). *U.S. Dep. Commer., NOAA Tech. Rep. NMFS* 130.

- 1 Mangels, K. F., and T. Gerrodette. 1994. Report of cetacean sightings during a marine mammal survey
2 in the eastern Pacific Ocean and the Gulf of California aboard the NOAA ships "MacArthur"
3 and "David Starr Jordan" July 28-November 6, 1993. NOAA Tech. Memo. NMFS-
4 SWFSC-221. 88 p.
- 5
- 6 Marine Mammal Commission. 1999. Northern right whale, *Eubalaena glacialis*. Pp. 3-24 in Marine
7 Mammal Commission Annual Report to Congress, 1998. Marine Mammal Commission, 4340
8 East-West Highway, Room 905, Bethesda, Maryland 20814.
- 9
- 10 Masaki, Y. 1977. The separation of the stock units of sei whales in the North Pacific. Rep. Int. Whal.
11 Comm. (Spec. Iss. 1):71-79.
- 12
- 13 Masaki, Y. 1976. Biological studies on the North Pacific sei whale. Bull. Far Seas Fish. Res. Lab.
14 (Shimizu) 14:1-104.
- 15
- 16 Marmorek, D.R., C.N. Peters, and I. Parnell. 1998. Plan for analyzing and testing hypotheses (PATH) -
17 Final report for fiscal year 1998. December 16, 1998. 263 p.
- 18
- 19 Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 Gulf of Alaska bottom trawl survey. U.S.
20 Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59, 217 pp.
- 21
- 22 Mate, B.R. 1973. Population kinetics and related ecology of the northern sea lion, *Eumetopias jubatus*,
23 and the California sea lion, *Zalophus californianus*, along the Oregon Coast. Ph.D. dissertation,
24 University of Oregon, 94 pp.
- 25
- 26 Mathisen, O.A., R.T. Baade, and R.J. Lopp. 1962. Breeding Habits, Growth and Stomach Contents of
27 the Steller Sea Lion in Alaska. J. of Mammal. 43:469-477.
- 28
- 29 Maury, M.F. 1852. Whale chart of the world, (The wind and current charts), Series F, Washington, D.C.
- 30
- 31 McDermott, S.F. 1994. Masters. University of Washington. 76 pp.
- 32
- 33 McDermott, S.F., and S.A. Lowe. 1997. The reproductive cycle and sexual maturity of Atka mackerel
34 (*Pleurogrammus monopterygius*) in Alaska waters. Fish. Bull. U.S. 95:231-233.
- 35
- 36 McDonald, D.L. And P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration
37 estimates of leatherback turtles (*Dermochelys coriacea*) in St. Croix, Us. Virgin Islands, 1979-
38 1995. Chelonian Conservation and Biology (as reported in NMFS and USFWS 1998).
- 39
- 40 McDonald, M. A., J. A. Hildebrand, S. Webb, L. Dorman, and C. G. Fox. 1993. Vocalizations of blue
41 and fin whales during a midocean ridge airgun experiment. J. Acoust. Soc. Am. 94(3,pt.2):1849.
- 42
- 43 McFarlane, G.A., and R.J. Beamish. 1990. Effect of an external tag on growth of sablefish
44 (*Anoplopoma fimbria*) and consequences to mortality and age at maturity. Canadian J. Fish.
45 Aquat. Sci. 47:1551-1557.
- 46
- 47 McFarlane, G.A., and W.D. Nagata. 1988. Overview of sablefish mariculture and its potential for
48 industry. Pp. 105-120 in Proceedings of the Fourth Alaska Aquaculture Conference, Alaska Sea
49 Grant Report 88-4 University of Alaska Fairbanks, Fairbanks, AK 99775.
- 50

- 1 McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Bull.
2 Fish. Res. Board Canada 173: 381.
3
- 4 Megrey, B.A. and V. G. Wespestad. 1990. Alaskan groundfish resources: 10 years of management
5 under the Magnuson Fishery Conservation and Management Act. N. Amer. J. Fisheries
6 Management 1): 125-143.
7
- 8 Megrey, B.A., A.B. Hollowed, S.R. Hare, S.A. Macklin, and P.J. Stabeno. 1996. Contributions of FOCI
9 research to forecasts of year-class strength of walleye pollock in Shelikof Strait, Alaska. Fish.
10 Oceanogr. 5:189-203.
11
- 12 Merati, N., and R.D. Brodeur. 1997. Feeding habits and daily ration of juvenile walleye pollock in the
13 western Gulf of Alaska. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 126. pp. 65-80.
14
- 15 Merrick, R.L. 1995. The relationship of the foraging ecology of Steller sea lions (*Eumetopias jubatus*)
16 to their population decline in Alaska. Ph.D. dissertation, University of Washington.
17
- 18 Merrick, R.L., R. Brown, D.G. Calkins, and T.R. Loughlin. 1995. A comparison of Steller sea lion,
19 *Eumetopias jubatus*, pup masses between rookeries with increasing and decreasing populations.
20 Fish. Bull. 93:753-758.
21
- 22 Merrick, R.L., and D.G. Calkins. 1996. Importance of juvenile walleye pollock, *Theragra*
23 *chalcogramma*, in the diet of Gulf of Alaska Steller sea lions, *Eumetopias jubatus*. Pp. 153-166
24 in U.S. Dep. of Commer., NOAA Tech. Rep. NMFS 126.
25
- 26 Merrick, R.L., M.K. Chumbley, and G.V. Byrd. 1997. Diet diversity of Steller sea lions (*Eumetopias*
27 *jubatus*) and their population decline in Alaska: a potential relationship. Can. J. Fish. Aquat. Sci.
28 54:1342-1348.
29
- 30 Merrick, R., P. Gearin, S. Osmek, and D. Withrow. 1988. Field Studies of Northern sea lions at Ugamak
31 Island, Alaska during the 1985 and 1986 breeding seasons. U.S. Dep. of Commer., NOAA Tech.
32 Memo. NMFS F/NWC-143.
33
- 34 Merrick, R.L., and T.R. Loughlin. 1997. Foraging behavior of adult female and young-of-the-year Steller
35 sea lions (*Eumetopias jubatus*) in Alaskan waters. Can. J. of Zool. 75 (5):776-786.
36
- 37 Merrick, R.L., T.R. Loughlin, G.A. Antonelis, and R. Hill. 1994. Use of satellite-linked telemetry to
38 study Steller sea lion and northern fur seal foraging. Pol. Res. 13:105-114.
39
- 40 Merrick, R.L., T.R. Loughlin, and D.G. Calkins. 1987. Decline in abundance of the northern sea lion,
41 *Eumetopias jubatus*, in 1956-86. Fish. Bull., U.S. 85:351-365.
42
- 43 Merrick, R.L., and A.E. York. 1994. A viability analysis for the southwest Alaskan Steller sea lion
44 population, 1985-94. Draft report, 20 pp.
45
- 46 Methot, R.D. 1990. Synthesis model: An adaptable framework for analysis of diverse stock assessment
47 data. International North Pacific Fisheries Commission Bulletin, 50, International North Pacific
48 Fisheries Commission, 6640 Northwest Marine Drive, Vancouver, BC, Canada V6T 1X2. pp.
49 259-277.
50

- 1 Miller, A.J., D.R. Cayan, T.P. Barnett, N.E. Graham, and J.M. Oberhuber. 1994. The 1976-77 Climate
2 Shift of the Pacific Ocean. *Oceanography* 7:21-26.
3
- 4 Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984a. The blue whale, *Balaenoptera musculus*. *Mar.*
5 *Fish. Rev.* 46(4):15-19.
6
- 7 Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984b. The fin whale, *Balaenoptera physalus*. *Mar.*
8 *Fish. Rev.* 46(4):20-24.
9
- 10 Mizue, K. 1951. Food of whales (in the adjacent waters of Japan). *Sci. Rep. Whales Res. Inst.* 5:81-90.
11
- 12 Morris, B.F. 1981. An assessment of the living marine resources of the central Bering Sea and potential
13 resource use conflicts between commercial fisheries and Petroleum development in the Navarin
14 Basin, Proposed sale No. 83. *In* U.S. Dep. Commer., NOAA, NMFS, Environmental Assessment
15 Division, P.O. Box 21668, Juneau, AK 99802.
16
- 17 Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the Gulf of Alaska: a
18 resource assessment for the Gulf of Alaska/Cook Inlet Proposed Oil and Gas Lease Sale 88. *In*
19 U.S. Dep. Commer., NOAA, NMFS.
20
- 21 Murison, L. D., and D. E. Gaskin. 1989. The distribution of right whales and zooplankton in the Bay of
22 Fundy, Canada. *Can. J. Zool.* 67:1411-1420.
23
- 24 Murphy, E. J., D. J. Morris, J. L. Watkins, and J. Priddle. 1988. Scales of interaction between
25 Antarctic krill and the environment. *In* D. Sahrage (Editor) Antarctic ocean and
26 resources variability, p.120-130. Springer-Verlag., Berlin and N.Y.
27
- 28 Musienko, L.N. 1970. Razmnozheine i razvitie ryb Beringova morya (Reproduction and development of
29 Bering Sea fishes). *Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Koz. Okeanogr.* 70:161-224 in
30 P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5, available
31 *Natl. Tech. Info. Serv.*, Springfield, VA as TT 74-50127.
32
- 33 Myers, K.W., K.Y. Aydiu, R.V. Walker, S. Fowler and M.L. Dahlberg. 1996. Known ocean ranges of
34 stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. (NPAFC
35 Doc. 192) *Fish Res. Inst.*, Univ. Wash., Seattle (FRI-UW-9614). 4p w/ figs. and append.
36
- 37 Myers and 10 co-authors. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and
38 California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443p
39
- 40 Nasu, K. 1974. Movement of baleen whales in relation to hydrographic conditions in the northern part
41 of the North Pacific Ocean and the Bering Sea. Pp. 345-361 *in* D.W. Hood and E.J. Kelley
42 (eds.), *Oceanography of the Bering Sea*. Institute of Marine Science, Univ. of Alaska, Fairbanks.
43
- 44 National Marine Fisheries Service (NMFS). 1991a. Final recovery plan for the humpback whale
45 (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National
46 Marine Fisheries Service, Silver Spring, Maryland. 105 pp.
47
- 48 NMFS. 1991b. Recovery plan for the northern right whale (*Eubalaena glacialis*). Prepared by the Right
49 Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 86
50 pp.

- 1 NMFS. 1992. Recovery plan for the Steller sea lion (*Eumetopias jubatus*). Prepared by the Steller Sea
2 Lion Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 92 pp.
3
- 4 NMFS. 1995. Status review of the United States Steller sea lion, *Eumetopias jubatus*, population. U.S.
5 Dep. Commer., NOAA, National Marine Mammal Laboratory, AFSC, 7600 Sand Point Way NE,
6 Seattle, WA 98115. 61 pp.
7
- 8 NMFS. 1998. Section 7 consultation on the authorization of the Bering Sea and Aleutian Islands
9 groundfish fishery for walleye pollock under the BSAI FMP, on the authorization of the Bering
10 Sea and Aleutian Islands Atka mackerel fishery under the BSAI FMP, and the authorization of
11 the Gulf of Alaska groundfish fishery for walleye pollock under the GOA FMP, between 1999
12 and 2002. Office of Protected Resources, NMFS. Dec. 3, 1998.
13
- 14 NMFS. 1998a. Recovery plan for the blue whale (*Balaenoptera musculus*). Prepared by R.R. Reeves,
15 P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber for the National Marine Fisheries Service,
16 Silver Spring, MD. 42 pp.
17
- 18 NMFS. 1998b. Draft recovery plan for the fin whale *Balaenoptera physalus* and sei whale *Balaenoptera*
19 *borealis*. Prepared by R.R. Reeves, G.K. Silber, and P. Michael Payne for the National Marine
20 Fisheries Service, Silver Spring,
21
- 22 NMFS. 1998c. Endangered Species Act - Section 7 Consultation - Managing the Southeast Alaska
23 salmon fisheries subject to the Fishery Management Plan for Salmon Fisheries off the Coast of
24 Alaska and the U.S. Letter of Agreement Regarding Chinook Salmon Fisheries in Alaska.
25 NMFS, Protected Resources Division. June 29, 1998. 22 pp.
26
- 27 NMFS. 1999. Section 7 consultation on the Bering Sea and Aleutian Islands groundfish fishery for
28 walleye pollock under the BSAI FMP and the Gulf of Alaska groundfish fishery for walleye
29 pollock under the GOA FMP for 2000. Office of Protected Resources, NMFS. Dec. 1999.
30
- 31 NMFS. 1999a. Endangered Species Act - Section 7 Consultation. Biological Opinion and Incidental
32 Take Statement. 1999 Treaty Indian and non-Indian fall season fisheries in the Columbia River
33 Basin. July 30, 1999. 68 p.
34
- 35 NMFS. 2000. Seasonal estimates of potential Steller sea lion prey species inside and outside of critical
36 habitat. Unpubl analysis completed for this opinion.
37
- 38 NMFS and FWS. 1998. Recovery Plan for U.S. Pacific Populations of the leatherback turtle
39 (*Dermochelys coriacea*). NMFS, Silver Spring, Maryland. 65 pp.
40
- 41 National Research Council, Committee on the Bering Sea Ecosystem. 1996. The Bering Sea Ecosystem.
42 National Academy Press, Washington, D.C.
43
- 44 Nemoto, T. 1957. Foods of baleen whales in the northern Pacific. Sci. Rep. Whales Res. Inst. 12:33-89.
45
- 46 Nemoto, T. 1970. Feeding pattern of baleen whales in the oceans. Pp. 241-252 in Steele, J.H. (ed.),
47 Marine Food Chains. University of California Press, Berkeley, CA.
48
- 49 Nemoto, T. 1978. Humpback whales observed within the continental shelf waters of the Bering Sea.
50 Sci. Rep Whales Res. Inst. Tokyo 39:245-247.

- 1 Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales
2 with special reference to the abundance of North Pacific sei and Bryde's whales. Rep. Int. Whal.
3 Comm., Special Issue 1:80-87.
4
- 5 Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, 351 p.
6
- 7 Nichol, D.G. 1994. Maturation and Spawning of female yellowfin sole in the Eastern Bering Sea.
8 Proceedings of the International Pacific Flatfish Symposium, Anchorage, AK. Alaska Sea Grant
9 College Program, University of Alaska, Fairbanks, 304 Eielson Building, Fairbanks, AK 99775.
10
- 11 Nichol, D.G. 1997. Effects of geography and bathymetry on growth and maturity of yellowfin sole,
12 *Pleuronectes asper*, in the eastern Bering Sea. Fish. Bull. 95:494-503.
13
- 14 Nicholas, J. 1995. Status of Willamette spring-run chinook salmon relative to Federal Endangered
15 Species Act considerations. Unpublished Report. November 30, 1995. 44 p.
16
- 17 Nikulin, P.G. 1946. Distribution of cetaceans in seas surrounding the Chukchi Peninsula. Trudy Inst.
18 Okeanol. Akad. Sci. USSR 22:255-257.
19
- 20 Nishiwaki, M. 1959. Humpback whales in Ryukyuan waters. Sci. Rep. Whales. Res. Inst. Tokyo 14:49-
21 86.
22
- 23 Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by
24 Japanese whaling results. Pp. 171-191 in Norris, K.S., (ed.), Whales, Dolphins and Porpoises.
25 University of California Press, Berkeley.
26
- 27 North Pacific Fishery Management Council (NPFMC). 1989. Fishery Management Plan for the
28 Commercial King and Tanner Crab Fisheries in the Bering Sea/Aleutian Islands area. North
29 Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501
30
- 31 NPFMC. 1994. Fishery Management Plan for the Gulf of Alaska Groundfish Fishery. In North Pacific
32 Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.
33
- 34 NPFMC. 1995. Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish. In North
35 Pacific Fishery Management Council, 605 West 4th Avenue, Suite 306, Anchorage, AK 99501.
36
- 37 NPFMC. 1996. Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the
38 Gulf of Alaska. Ecosystem Considerations. In North Pacific Fishery Management Council, 605
39 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
40
- 41 Nunnallee, E.P. 1991. An investigation of the avoidance reactions of Pacific whiting (*Merluccius*
42 *productus*) to demersal and midwater trawl gear. Int. Coun. Exp. Seas Paper/ B:5, U.Fish
43 Capture Committee. 17 pp.
44
- 45 Oregon Department of Fish and Wildlife (ODFW). 1997. Backgrounder - Willamette spring chinook.
46 February 21, 1997. 6 p.
47
- 48 ODFW/Washington Department of Fish and Wildlife (WDFW). 1998. Status Report: Columbia River
49 fish runs and fisheries, 1938-1997. ODFW and WDFW. June 1998.
50

- 1 O'Connell, V.M. 1987. Reproductive seasons for some *Sebastes* species in Southeastern Alaska. Alaska
2 Dep. Fish Game Information Leaflet. 263:21.
3
- 4 O'Connell, V.M., and D.W. Carlile. 1993. Habitat-specific density of adult yelloweye rockfish *Sebastes*
5 *ruberrimus* in the eastern Gulf of Alaska. Fish. Bull. 91:304-309.
6
- 7 O'Connell, V. M., D.W. Carlile, and C. Brylinsky. 1997. Demersal Shelf Rockfish. in Stock Assessment
8 and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected
9 for 1998. Gulf of Alaska Plan Team (eds.), North Pacific Fishery Management Council, 605 W.
10 4th Avenue, Suite 306, Anchorage, AK 99501.
11
- 12 O'Connell, V.M., D. Carlile, and C. Brylinsky. 1999. Demersal shelf rockfish. *In* Stock Assessment
13 and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of
14 Alaska Plan Team, pp. 427-466. (North Pacific Fishery Management Council, 605 W. 4th
15 Avenue, Suite 306, Anchorage, AK 99501)
16
- 17 O'Connell, V.M., and F.C. Funk. 1987. Age and growth of yelloweye rockfish (*Sebastes ruberrimus*)
18 landed in Southeastern Alaska. Pp. 171-185 *in* Proceedings of the International Rockfish
19 Symposium, B. R. Melteff (ed.), Alaska Sea Grant Report 87-2 Alaska Sea Grant.
20
- 21 Odum, E. P. 1971. Fundamentals of ecology. Third Edition. Saunders College Publishing; Philadelphia,
22 Pennsylvania.
23
- 24 Ohsumi, S., and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Rep. Int. Whal.
25 Comm. 24:114-126.
26
- 27 Olla, B.L., M.W. Davis, C.H. Ryer, and S.M. Sogard. 1995. Behavioural responses of larval and
28 juvenile walleye pollock (*Theragra chalcogramma*): possible mechanisms controlling
29 distribution and recruitment. International Council for the Exploration of the Sea Marine
30 Science Symposium. 201. pp. 3-15.
31
- 32 Omura, H. 1958. North Pacific right whales. Sci. Rep. Whales Res. Inst. 13:1-52.
33
- 34 Omura, H., S. Ohsumi, T. Nemoto, k. Nasu, and T. Kasuya. 1969. Black right whales in the North
35 Pacific. Sci. Rept. Whales Res. Inst. 21:1-87.
36
- 37 Orcutt, H.G. 1950. The life history of the starry flounder, *Platichthys stellatus* (Pallas). Calif. Div. Fish
38 Game Fish. Bull. 78:64.
39
- 40 Osterhaus, A.D.M.E., and E.J. Vedder. 1988. Identification of virus causing recent seal deaths. Nature
41 350:20.
42
- 43 Pacific Fishery Management Council (PFMC). 1996. Review of the 1995 ocean salmon fisheries. Pacific
44 Fishery Management Council, 115 p. + app. (Available from Pacific Fishery Management
45 Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201.)
46
- 47 Paine, R.T. 1966. Food web complexity and species diversity. Amer. Nat. 100:65-75.
48
- 49 Payne, P.M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi. 1990. Recent
50 fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to

- 1 changes in selected prey. Fish. Bull., U.S. 88:687-696.
- 2
- 3 Pearcy, W.G. 1962. Egg masses and early development stages of the scorpaenid fish *Sebastes*. J.
- 4 Fish. Res. Board Canada. 19:1169-1173.
- 5
- 6 Perez, M.A. 1990. Review of marine mammal population and prey information for Bering Sea
- 7 ecosystem studies. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-186. 81 pp.
- 8
- 9 Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North
- 10 America. Fish. Bull. 84:959-973.
- 11
- 12 Perez, M.A., and T.R. Loughlin. 1991. Incidental catch of marine mammals by foreign and joint venture
- 13 trawl vessels in the U.S. EEZ of the North Pacific, 1973-88. NOAA Tech. Rep. NMFS 104, 57
- 14 pp.
- 15
- 16 Perry, S.L., D. P. DeMaster and G. K. Silber. 1999. The status of endangered whales: an overview.
- 17 Marine Fisheries Review 61: 1-74.
- 18
- 19 Peters, C.N., D.R. Marmorek, and I. Parnell (eds.). 1999. PATH decision analysis report for Snake
- 20 River fall chinook. Prepared by ESSA Technologies Ltd., Vancouver, BC. 332 pp.
- 21
- 22 Piatt, J.F. and P.J. Anderson. 1996. Responses of common murrelets to the Exxon Valdez oil spill and
- 23 long-term changes in the Gulf of Alaska ecosystem. AFS Symposium 18, pp. 720-737.
- 24
- 25 Pike, G.C. 1958. Food of the Northern Sea Lion. Fish. Res. Bd. Canada 112:18-20.
- 26
- 27 Pike, G.C., and B.E. Maxwell. 1958. The abundance and distribution of the northern sea lion
- 28 (*Eumetopias jubata*) on the coast of British Columbia. J. Fish. Res. Bd. Canada 15:5-17.
- 29
- 30 Pitcher, K.W. 1980a. Stomach contents and feces as indicators of harbor seal, *Phoca vitulina*, foods in
- 31 the Gulf of Alaska. Fish. Bull. 78:797-798.
- 32
- 33 Pitcher, K.W. 1980b. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish.
- 34 Bull. 78:544-549.
- 35
- 36 Pitcher, K.W. 1981. Prey of the Steller sea lion, *Eumetopias jubatus*, in the Gulf of Alaska. Fish. Bull.
- 37 79:467-472.
- 38
- 39 Pitcher, K.W., and D.G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska.
- 40 J. Mammal. 62:599-605.
- 41
- 42 Pitcher, K.W., D.G. Calkins, and G.W. Pendleton. 1998. Reproductive performances of female Steller
- 43 sea lions from the Gulf of Alaska: Indications of nutritional stress? Can. J. Zool. 76: 2075-2083.
- 44
- 45 Pitcher, K.W., and F.H. Fay. 1982. Feeding by Steller sea lions on harbor seals. The Murrelet 63:70-71.
- 46
- 47 Porter, B. 1997. Winter ecology of Steller sea lions (*Eumetopias jubatus*) in Alaska. M.S. dissertation,
- 48 University of British Columbia, 84 pp.
- 49
- 50 Power, G., and J. Gregoire. 1978. Predation by freshwater seals on the fish community of Lower Sea

- 1 Lake, Quebec. J. Fish. Res. Board Can. 35:844-850.
2
3 Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea* in Pacific Mexico, with
4 a new estimate of the world population status. *Copeia* 1982: 741-747.
5
6 Radchenko, V.I. 1992. The role of Squid in the pelagic ecosystem of the Bering Sea. *Okeanologiya*.
7 32:1093-1101.
8
9 Rea, L.D., M.A. Castellini, B.S. Fadely, and T. R. Loughlin. 1998. Health status of young Alaska Steller
10 sea lion pups (*Eumetopias jubatus*) as indicated by blood chemistry and hematology. *Comp.*
11 *Biochem. Physiol. A.* 120: 617-623.
12
13 Rea, L.D., D.A.S. Rosen and A. W. Trites. 2000. Metabolic response to fasting in 6-week old Steller sea
14 lion pups (*Eumetopias jubatus*). *Canadian J. Zool.* 78: 890-894.
15
16 Rebel, T.P. 1974. Sea turtles and the turtle industry of the West Indies, Florida and the Gulf of Mexico.
17 Univ of Miami Press, Miami, Florida. 250 pp.
18
19 Reeves, R.R., S. Leatherwood, S.A. Karl, and E.R. Yohe. 1985. Whaling results at Akutan (1912-39)
20 and Port Hobron (1926-37), Alaska. *Rep. Int. Whal. Comm.* 35:441-457.
21
22 Reeves, R.R, and H. Whitehead. 1997. Status of the sperm whale, *Physeter macrocephalus*, in Canada.
23 *Can. Field Naturalist* 111(2):293-307.
24
25 Repenning, C.A. 1976. Adaptive evolution of sea lions and walruses. *Syst. Zool.* 25:375-390.
26
27 Restrepo, V.R., G.G. Thompson, P.M. Mace, W.L. Gabriel, L.L. Low, A.D. MacCall, R.D. Methot, J.E.
28 Powers, B.L. Taylor, P.R. Wade, and J.F. Witzig. 1998. Technical guidance on the use of
29 precautionary approaches to implementing National Standard 1 of the Magnuson-Stevens Fishery
30 Conservation and Management Act. NOAA Technical Memorandum NMFS-F/SPO-31, 54 pp.
31 (to my knowledge has not yet been put in record, see Grant Thompson)
32
33 Rice, D.W. 1974. Whales and whale research in the eastern North Pacific . Pp. 170-195 *in* Schevill,
34 W.E. (ed.), *The Whale Problem: A Status Report*. Harvard University Press, Cambridge, MA.
35 419 pp.
36
37 Rice, D.W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North
38 Pacific. *Rep. Int. Whal. Comm. (Spec. Iss. 1):*92-97.
39
40 Rice, D. W. 1978. Blue whale. *In* D. Haley (Editor), *Marine mammals of eastern North Pacific and*
41 *Arctic waters*, p.31-35. Pacific Search Press, Seattle, WA.
42
43 Rice, D.W. 1986a. Blue whale. Pp. 4-45 *in* D. Haley (ed.), *Marine Mammals of the Eastern North*
44 *Pacific and Arctic waters*. Second edition, Pacific Search Press.
45
46 Rice, D.W. 1986b. Sperm whales. Pp. 94-101 *in* D. Haley (ed.), *Marine Mammals of the Eastern North*
47 *pacific and Arctic Waters*, 2nd ed. Pacific Search Press, Seattle, WA.
48
49 Rice, D.W. 1992. The blue whales of the southeastern North Pacific Ocean. *AFSC Quarterly Report*,
50 October-December, pp. 1-3.

- 1 Rice, D.W., and A. Wolman. 1982. Whale census in the Gulf of Alaska, June to August 1980. Rep. Int.
2 Whal. Comm. 32:1-11.
3
- 4 Ricker, W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada
5 11(5):559-623.
6
- 7 Rickey, M.H. 1995. Maturity, spawning and seasonal movement of arrowtooth flounder, *Atheresthes*
8 *stomias*, off Washington. Fish. Bull. 93:127-138.
9
- 10 Ronholt, L.L., K. Wakabayashi, T.K. Wilderbuer, H. Yamaguchi, and K. Okada. 1985. Results of the
11 cooperative U.S.-Japan groundfish assessment survey in Aleutian Islands water, June-November
12 1980. Unpubl. manusc., U.S. Dep. Commer., NOAA, Northwest and Alaska Fisheries Science
13 Center, 7600 Sand Point Way NE, Seattle, WA 98115. 303 pp.
14
- 15 Rosen, D.A.S., and A.W. Trites. 1997. Heat Increment of Feeding in Steller Sea Lions, *Eumetopias*
16 *jubatus*. Comp. Biochem. Physiol. 118: 877-881.
17
- 18 Rosen, D.A.S, and A.W. Trites. 1999. Metabolic effects of a low-energy prey on Steller sea lions,
19 *Eumetopias jubatus*. Physiological Biochem. Zoology 77: 723-731.
20
- 21 Rosen, D.A.S, and A.W. Trites. 2000a. Digestive efficiency and dry-matter digestibility of Steller sea
22 lions fed herring, pollock, squid and salmon. Can. J. Zoology 78: 234-239.
23
- 24 Rosen, D.A.S, and A.W. Trites. 2000b. Pollock and the decline of Steller sea lions: testing the junk-
25 food hypothesis. Can. J. Zool. 78: 1243-1250.
26
- 27 Rosenthal, R.J., V.M. O'Connell, and M.C. Murphy. 1988. Feeding ecology of ten species of rockfishes
28 (Scorpaenidae) from the Gulf of Alaska. California Fish and Game. 74:16-37.
29
- 30 Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pp. 189-195 in
31 Bjorndal, K.A. (Ed.), biology and conservation of sea turtles. Smithsonian Inst. Press,
32 Washington, D.C.
33
- 34 Rutecki, T.L., and E.R. Varosi. 1997. Migrations of juvenile sablefish, *Anoplopoma fimbria*, in
35 southeast Alaska. In Biology and Management of Sablefish, *Anoplopoma fimbria*, M. E.
36 Wilkins, M. W. Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
37
- 38 Salden, D. R. 1988. Humpback whale encounter rates offshore of Maui, Hawaii. J. Wildl.
39 Manage. 52(2):301-304.
40
- 41 Sandgren, F.E. 1970. Breeding and maternal behavior of the Steller sea lion (*Eumetopias jubatus*) in
42 Alaska. The Zoological Institute, University of Stockholm, Swedish Museum of Natural History,
43 138 pp.
44
- 45 Sarti, M. L., S. A. Eckert, N. Garcia T., and A. R. Barragan. 1996. Decline of the world's largest nesting
46 assemblage of leatherback turtles. Mar. Turtle Newsl. 74: 2-5.
47
- 48 Scarff, J.E. 1986. Historic and present distribution of the right whale (*Eubalaena glacialis*) in the
49 eastern North Pacific south of 50°N and east of 180°W. Pp. 43-63. In Brownell Jr., R.L., P.B.
50 Best, and J.H. Prescott (eds.), Right Whales: Past and Present Status. Rpts. of the IWC; Special
November 30, 2000

1 Issue No. 10. Cambridge, England. 286 pp.

2
3 Scheffer, V.B. 1946. Growth and behavior of young sea lions. *J. of Mammal.* 26:390-392. **Spelling?**

4
5 Schneider, D.C., and V.P. Shuntov. 1993. The trophic organization of the marine bird community in the
6 Bering Sea. *Rev. Fish. Sci.* 1:311-335.

7
8 Schumacher, J. D., P.J. Stabeno, and S.J. Bograd. 1993. Characteristics of an eddy over a continental
9 shelf: Shelikof Strait, Alaska. *J. Geophys. Res.* 98:8395-8404.

10
11 Sears, R. 1990. The Cortez Blues. *Whalewatcher* 24(2): 12-15 2

12
13 Sease, J. and T. R. Loughlin. 1999. Aerial and land-based surveys of Steller sea lions in Alaska, June
14 and July 1997 and 1998. NOAA Tech Memorandum, NMFS-AFSC-100. 61 pp.

15
16 Sease, J. 2000. Summary of 1999 Steller sea lion surveys, unpubl. data. National Marine Mammal
17 Laboratory, NMFS, Seattle, WA.

18
19 Sease, J.L., and T.R. Loughlin. 1999. Aerial and land-based surveys of Steller sea lions (*Eumetopias*
20 *jubatus*) in Alaska, June and July 1997 and 1998. U.S. Dep. Commer., NOAA Tech. Memo.
21 NMFS-AFSC-100.

22
23 Sheldon, K.E.W. and D.J. Rugh. 1995. The bowhead whale, *Balaena mysticetus*: its historic and current
24 status. *Marine Fisheries Review* 57(3-4):1-20.

25
26 Shima, M., A. B. Hollowed and G.R. Van Blaricom. 2000. Response of pinniped populations to directed
27 harvest, climate variability, and commercial fishery activity: a comparative analysis. *Rev. in*
28 *Fish Science* 8(2): 89-124.

29
30 Shimada, A.M., and D.K. Kimura. 1994. Seasonal movements of Pacific cod (*Gadus macrocephalus*) in
31 the eastern Bering Sea and adjacent waters based on tag-recapture data. *Fish. Bull.* 92:800-816.

32
33 Shuntov, V.P., A.F. Volkov, O.S. Temnykh, and Y.P. Dulepova. 1993. Pollock in the ecosystem of the
34 far eastern seas. *Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr. (TINRO),*
35 *Vladivostok.* 426.

36
37 Sigler, F.A., J.T. Fujioka, and S.A. Lowe. 1997a. Sablefish. *In* Stock Assessment and Fishery
38 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
39 Projected for 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 323-360. (North Pacific
40 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)

41
42 Sigler, F.A., J.T. Fujioka, and S.A. Lowe. 1999. Alaska sablefish assessment for 2000. *In* Stock
43 Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering
44 Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team, pp. 469-518. (North
45 Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)

46
47 Sigler, M.F., S.A. Lowe, and C.R. Kastle. 1997b. Age and depth differences in the age-length
48 relationship of sablefish, *Anoplopoma fimbria*, in the Gulf of Alaska. Pp. 55-63 *in* *Biology and*
49 *Management of Sablefish, Anoplopoma fimbria*, (Papers from the International Symposium on

- 1 the Biology and Management of Sablefish, Seattle, Washington, 13-15 April 1993) M. E.
2 Wilkins, M. W. Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
3
- 4 Sigurjónsson, J. 1995. On the life history and autecology of North Atlantic rorquals. Pp. 425-441 in
5 A.S. Blix, L. Walløe, and Ø. Ulltang (eds.), Whales, Seals, Fish, and Man. Elsevier Science.
6
- 7 Sinclair, E.H., G.A. Antonelis, B.W. Robson, R.R. Ream, and T.R. Loughlin. 1997. Northern fur seal
8 predation on juvenile walleye pollock. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 126.
9
- 10 Sinclair, E.H., T. Loughlin, and W. Pearcy. 1994. Prey selection by northern fur seals (*Callorhinus*
11 *ursinus*) in the eastern Bering Sea. Fish. Bull. 92:144-156.
12
- 13 Skud, B.E. 1982. Dominance in fisheries: the relation between environment and abundance. Science
14 216:144-149.
15
- 16 Sleptsov, M.M. 1950. Concerning the biology of the far-eastern sea lion. Izvestiia Tikhookean-skogo
17 N.-I Instituta Rybnogo Khoziaistva I Okeanografii [TINRO], Vol. 32. [Translated by J.W.
18 Brooks.]
19
- 20 Sleptsov, M.M. 1955. Biology of whales and the whaling fishery in Far Eastern seas. 'Pishch.
21 Prom.', Moscow [In Russian] (Transl. with comments and conclusions only by Fish. Res. Board
22 Can., Transl. Ser. 118, 6 pp.)
23
- 24 Small, R. J., and D. P. DeMaster. 1995. Alaska marine mammal stock assessments 1995. U.S. Dep.
25 Commer., NOAA Tech. Memo. NMFS-AFSC-57, 93 p.
26
- 27 Sobolevsky, Y.I. 1996. Species composition and distribution of squids in the western Bering Sea. Pp.
28 135-141 in Ecology of the Bering Sea: a review of Russian literature, O.A. Mathisen, K.O.
29 Coyle (eds.) Alaska Sea Grant College Program Report 96-01 University of Alaska Fairbanks,
30 Fairbanks, AK 99775.
31
- 32 Sogard, S.M., and B.L. Olla. 1993. Effects of light, thermoclines and predator presence on vertical
33 distribution and behavioral interactions of juvenile walleye pollock, *Theragra chalcogramma*
34 Pallas. J. Exp. Mar. Biol. Ecol. 167:179-195.
35
- 36 Sogard, S.M., and B.L. Olla. 1996. Food deprivation affects vertical distribution and activity of marine
37 fish in a thermal gradient: potential energy-conserving mechanisms. Mar. Ecol. Prog. Ser.
38 133:43-55.
39
- 40 Spaulding, G.C. 1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the
41 British Columbia coast. Fish. Res. Bd. Canada, Bull. No. 146.
42
- 43 Spencer, P.D., G.E. Walters, and T.K. Wilderbuer. 1999a. Flathead sole. In Stock Assessment and
44 Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands
45 Region. Bering Sea/Aleutian Islands Plan Team, pp. 391-430. (North Pacific Fishery
46 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
47
- 48 Spencer, P.D., G.E. Walters, and T.K. Wilderbuer. 1999b. Other flatfish. In Stock Assessment and
49 Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands
50 Region. Bering Sea/Aleutian Islands Plan Team, pp. 431-468. (North Pacific Fishery

1 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)

- 2
- 3 Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996.
4 Worldwide population decline of *Dermochelys coriacea*: Are leatherback turtles going extinct?
5 Chelonian Cons. and Biol. 2(2):209-222.
- 6
- 7 Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback
8 turtles face extinction. Nature. Vol. 45. June 1, 2000.
- 9
- 10 Springer, A.M. 1992. A review: Walleye pollock in the North Pacific - how much difference do they
11 really make? Fish. Oceanogr. 1:80-96.
- 12
- 13 Stabeno, P.J., R.K. Reed, and J.D. Schumacher. 1995. The Alaska Coastal Current: continuity of
14 transport and forcing. J. Geophys. Res. 100:2477-2485.
- 15
- 16 Stansby, M.E. 1976. Chemical characteristics of fish caught in the northeast Pacific Ocean. Mar. Fish.
17 Rev. 38, paper 1198, 11 pp.
- 18
- 19 Stewart, B.S., S.A. Karl, P.K. Yochem, S. Leatherwood, and J.L. Laake. 1987. Aerial surveys for
20 cetaceans in the former Akutan, Alaska, whaling grounds. Arctic 40:33-42.
- 21
- 22 Stinson, M.S. 1984. Biology of sea turtles in San Diego Bay, California, and in the northeastern Pacific
23 Ocean. MS Thesis, San Diego State University, 576 pp.
- 24
- 25 Strict, J.M., L.W. Fritz, and J.P. Lewis. 1997. Aerial and ship-based surveys of Steller sea lions
26 (*Eumetopias jubatus*) in southeast Alaska, the Gulf of Alaska, and Aleutian Islands during June
27 and July 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-71, 55pp.
- 28
- 29 Strick, J.M., R.L. Merrick, D.C. McAllister, L.W. Fritz, and K.M. Wynne. *In press*. Aerial and ship-
30 based surveys of Steller sea lions (*Eumetopias jubatus*) in sou southeast Alaska, the Gulf of
31 Alaska, and Aleutian Islands during June and July 1996. U.S. Dep. Commer., NOAA Tech.
32 Memo. NMFS-AFSC-00.
- 33
- 34 Swain, U.G., and D.G. Calkins. 1997. Foraging behavior of juvenile Steller sea lions in the northeastern
35 Gulf of Alaska: Diving and foraging trip duration. Pp. 91-106 *in* Steller sea lion recovery
36 investigations in Alaska, 1995-1996. Alaska Dept. of Fish and Game, Div. of Wildl. Conserv.,
37 NOAA Contract Report, Contract NA57FX0256, August 1997.
- 38
- 39 Swingle, W. M., S. G. Barco, and T. D. Pitchford. 1993. Appearance of juvenile humpback whales
40 feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9:309-315.
- 41
- 42 Tanasichuk, R.W. 1997. Diet of sablefish, *Anoplopoma fimbria*, from the southwest coast of Vancouver
43 Island. *in* Biology and Management of Sablefish, *Anoplopoma fimbria*, M.E. Wilkins, M.W.
44 Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
- 45
- 46 Tarasevich, M.N. 1968. Pishchevye svyazi kasholotov v severnoi chasti Tikhogo Okeana. [Food
47 connections of the sperm whales of the Northern Pacific.] [In Russian.] Zool. Zhur. 47:595-601.
48 (Transl. by K. Coyle, univ. Alaska, Fairbanks, 1982, 11 pp.)
- 49
- 50 Templeman, W. 1973. Distribution and abundance of the Greenland halibut, *Rheinhardtius*

1 *hippoglossoides* (Walbaum) in the Northwest Atlantic. Internatl. Comm. Northwest Atl. Fish.
2 Res. Bull. 10:82-98.
3

4 Tershy, B. R., J. Urbán-R., D. Breese, L. Tojas-B., and L. T. Findley. 1993. Are fin whales resident to the
5 Gulf of California? Rev. Invest. Cient., Univ. Auton. de Baja California Sur. 1: 69-71.
6

7 Theilacker, G.H., K.M. Bailey, M.F. Canino, and S.M. Porter. 1996. Variations in larval walleye
8 pollock feeding and condition: a synthesis. Fish. Oceanogr. 5:112-123.
9

10 Thompson, G.G. 1993. A proposal for a threshold stock size and fishing mortality rate. in Risk
11 Evaluation and Biological Reference Points for Fisheries Management, S. J. Smith, J. J. Hunt,
12 D. Rivard, Eds., Can. Spec. Publ. Fish. Aquat. Sci. 120 p.
13

14 Thompson, G.G., and M.W. Dorn. 1997. Pacific cod. Pp. 121-158 in Stock Assessment and Fishery
15 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
16 Projected for 1998. Bering Sea/Aleutian Islands Plan Team (eds.), North Pacific Fishery
17 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
18

19 Thompson, G.G., and M.W. Dorn. 1999. Assessment of the Pacific cod in the eastern Bering Sea and
20 Aleutian Islands area. In Stock Assessment and Fishery Evaluation Report for the Groundfish
21 Resources of the Bering Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team,
22 pp. 151-230. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
23 Anchorage, AK 99501)
24

25 Thompson, G.G., and R.D. Methot. 1993. Pacific cod. In Stock assessment and fishery evaluation
26 report for the groundfish resources of the Bering Sea/Aleutian Islands region as projected for
27 1994. Bering Sea/Aleutian Islands Plan Team (eds.), North Pacific Fishery Management
28 Council, 605 W. 4th Avenue, Suite, 306, Anchorage, AK 99501.
29

30 Thompson, G.G., and A.M. Shimada. 1990. Pacific cod. Pp. 44-66 in Condition of groundfish resources
31 of the eastern Bering Sea-Aleutian Islands region as assessed in 1988, L. L. Low, R. E. Narita
32 (eds.), U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-178.
33

34 Thompson, G.G., and H.H. Zenger. 1994. Pacific cod. In Stock assessment and fishery evaluation report
35 for the groundfish resources of the Gulf of Alaska as projected for 1995. Gulf of Alaska Plan
36 Team (eds.), North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
37 Anchorage, AK 99501.
38

39 Thompson, G.G., H.H. Zenger, and M.W. Dorn. 1997. Pacific cod. In Stock Assessment and Fishery
40 Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for 1998.
41 Gulf of Alaska Plan Team, eds., pp. 121-164. (North Pacific Fishery Management Council, 605
42 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
43

44 Thompson, G.G., H.H. Zenger, and M.W. Dorn. 1999. Assessment of the Pacific cod in the Gulf of
45 Alaska. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the
46 Gulf of Alaska. Gulf of Alaska Plan Team, pp. 105-184. (North Pacific Fishery Management
47 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
48

49 Thorsteinson, F.V., and C.J. Lensink. 1962. Biological observations of Steller sea lions taken during an
50 experimental harvest. J. Wildl. Management 26:353-359.

- 1 Tikhomirov, E.A. 1964. Distribution and biology of pinnipeds in the Bering Sea. From materials of first
2 expedition in Soviet Investigations in the northeast Pacific, Part III. U.S. Dept. Interior.
3 Translation 1968.
4
- 5 Tillman, M.F. 1977. Estimates of population size for the North Pacific sei whale. Rep. Int. Whal.
6 Comm. (Spec. Iss. 1):98-106.
7
- 8 Tomilin, A.G. 1967. Mammals of the USSR and adjacent countries. Vol. 9, Cetacea. Israel Program
9 Sci. Transl. No. 124, natl. Tech. Inf. Serv. TT 65-50086. Springfield, VA 717 pp. (Translation of
10 Russian text published in 1957).
11
- 12 Tønnessen, J.N. and O. Johnsen 1982. The history of modern whaling. University of California Press;
13 Berkeley, California.
14
- 15 Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American
16 whaleships. Zoologica (N.Y.) 19:1-50.
17
- 18 Trenberth, K.E. 1990. Recent observed interdecadal climate changes in the northern hemisphere. Bull.
19 Amer. Meteorological Soc. 71:988-993.
20
- 21 Trenberth, K.E., and J.W. Hurrell. 1994. Decadal atmosphere-ocean variations in the Pacific. Clim.
22 Dyn. 9:303-319.
23
- 24 Trites, A.W., and P.A. Larkin. 1992. The status of Steller sea lion populations and the development of
25 fisheries in the Gulf of Alaska and Aleutian Islands. A report of the Pacific States Marine
26 Fisheries Commission pursuant to National Oceanic and Atmospheric Administration Award No.
27 NA17FD0177. Fisheries Centre, University of British Columbia, Vancouver, British Columbia,
28 Canada V6T 1Z4.
29
- 30 Trites, A.W., and P.A. Larkin. 1996. Changes in the abundance of Steller sea lions (*Eumetopias*
31 *jubatus*) in Alaska from 1956 to 1992: how many were there? Aquat. Mamm. 22:153-166.
32
- 33 Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1997. Flatfish. In Stock Assessment and Fishery
34 Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for 1998.
35 Gulf of Alaska Plan Team, eds., pp. 165-192. North Pacific Fishery Management Council, 605
36 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
37
- 38 Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1999. Arrowtooth flounder. In Stock Assessment and
39 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska
40 Plan Team, pp. 225-254. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite
41 306, Anchorage, AK 99501)
42
- 43 Utter, R., G. Milner, G. Stahl, and D. Teel. 1989. Genetic population structure of chinook salmon
44 (*Oncorhynchus tshawytscha*), in the Pacific Northwest. Fish. Bull. 87:239-264.
45
- 46 Varanasi, U., J.E. Stein, W.L. Reichert, K.L. Tilbury, M.M. Krahn, and S.Chan. 1992. Chlorinated and
47 aromatic hydrocarbons in bottom sediments, fish and marine mammals in U.S. coastal waters:
48 laboratory and field studies of metabolism and accumulation. In C.H. Walker and D.R.
49 Livingstone (eds.), Persistent Pollutants in Marine Ecosystems, 115 pp.
50

- 1 von Ziegesar, O. 1984. A survey of the humpback whales in southeastern Prince William Sound,
2 Alaska: 1980, 1981, and 1983. Report to the Sate of Alaska, Alaska Council on Science and
3 Technology, 34 pp.
4
- 5 von Ziegesar, O., and C.O. Matkin. 1986. Humpback whales in Prince William Sound in 1985: a
6 contract report. Contract No. 41 USC 252, NMFS, National Marine Mammal Laboratory,
7 Seattle.
8
- 9 Wada, S. 1980. Japanese whaling and whale sighting in the North Pacific 1978 season. Rep. Int. Whal.
10 Comm. 30:415-424.
11
- 12 Wade, P. R., and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the Eastern
13 Tropical Pacific. Rep. Int. Whal. Comm. 43:477-493.
14
- 15 Waite, J.M., M.E. Dahlheim, R.C. Hobbs, S.A. Mizroch, O. von Ziegesar-Markin, J.M. Straley, L.M.
16 Herman, and J. Jacobsen. 1998. Evidence of a feeding aggregation of humpback whales
17 (*Megaptera novaeangliae*) around Kodiak Island, Alaska. Marine Mammal Science 15: 210-220.
18
- 19 Waite, J.M. and R. C. Hobbs. 1999. Small cetacean aerial survey of Prince William Sound and the
20 western Gulf of Alaska in 1998 and preliminary abundance harbor porpoise estimates for the
21 southeast Alaska and the Gulf of Alaska stocks. Ann Rept 1998, Office of Protected Resources,
22 NMFS, Silver Spring, Md. 15 pp.
23
- 24 Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. U.S. Dep. Commer.,
25 NMFS Proc. Rep., 88 pp.
26
- 27 Walline, P.D. 1983. Ph.D. Dissertation. University of Washington. 144 pp.
28
- 29 Walters, G.E., and T.K. Wilderbuer. 1997. Flathead sole. *In* Stock Assessment and Fishery Evaluation
30 Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for
31 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 271-296. (North Pacific Fishery
32 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
33
- 34 Waples, R.S., R.P Jones, Jr., B.R. Beckman, and G.A. Swan. 1991. Status Review for Snake River fall
35 chinook salmon. NOAA Technical Memorandum. NMFS F/NWC-201. June 1991. 73 p.
36
- 37 Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western
38 Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock
39 inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212p. + 5 regional volumes.
40
- 41 Watkins, W. A., K. E. Moore, D. Wartzok, and J. H. Johnson. 1981. Radio tracking of finback
42 (*Balaenoptera physalus*) and humpback (*Megaptera novaeangliae*) whales in Prince
43 William Sound, Alaska. Deep-Sea Res. 28A(6):577-588.
44
- 45 Wertheimer, A.C. 1997. The status of Alaska salmon. Pacific salmon and their ecosystems; status and
46 future options. Symposium Proceedings, Seattle, WA, pp. 179-197.
47
- 48 Wespestad, V.G. 1993. The status of Bering Sea pollock and the effect of the Donut Hole fishery. Fish.
49 18:18-25.
50

- 1 Wespestad, V.G., L.W. Fritz, W.J. Ingraham, and B.A. Megrey. 1997a. On Relationships between
2 Cannibalism, climate variability, physical transport and recruitment success of Bering Sea
3 Walleye Pollock, *Theragra chalcogramma*. ICES International Symposium, Recruitment
4 Dynamics of exploited marine populations: physical-biological interactions. Baltimore, MD.
5
- 6 Wespestad, V.G., J.N. Ianelli, L. Fritz, T. Honkalehto, N. Williamson, and G. Walters. 1997b. Bering
7 Sea-Aleutian Islands walleye pollock assessment for 1998. *In* Stock Assessment and Fishery
8 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
9 Projected for 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 35-120. (North Pacific
10 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501).
11
- 12 Wespestad, V.G., and J.M. Terry. 1984. Biological and economic yields for Bering Sea walleye pollock
13 under different fishing regimes. *N. Amer. J. Fish. Manage.* 4:204-215.
14
- 15 Westrheim, S.J. 1996. On the Pacific cod (*Gadus macrocephalus*) in British Columbia waters, and a
16 comparison with Pacific cod elsewhere, and Atlantic cod (*G. morhua*). *Canadian Tech. Rep.*
17 *Fish. Aquat. Sci.* 2092:390.
18
- 19 Whitehead, H. 1982. Populations of humpback whales in the northwest Atlantic. *Rep. Int. Whal.*
20 *Comm.* 32:345-353.
21
- 22 Whitehead, H. 1987. Updated status of the humpback whale, *Megaptera novaeangliae*, in Canada.
23 *Canadian Field-Naturalist* 101(2):284-294.
24
- 25 Wilderbuer, T.K. 1997. Yellowfin sole. *In* Stock Assessment and Fishery Evaluation Report for the
26 Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1998. Bering
27 Sea/Aleutian Islands Plan Team, eds., pp. 159-186. North Pacific Fishery Management Council,
28 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
29
- 30 Wilderbuer, T.K., and D. Nichol. 1999. Yellowfin sole. *In* Stock Assessment and Fishery Evaluation
31 Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. Bering
32 Sea/Aleutian Islands Plan Team, pp. 231-278. (North Pacific Fishery Management Council, 605
33 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
34
- 35 Wilderbuer, T.K., and T.M. Sample. 1999. Arrowtooth flounder. *In* Stock Assessment and Fishery
36 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region.
37 Bering Sea/Aleutian Islands Plan Team, pp. 315-348. (North Pacific Fishery Management
38 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
39
- 40 Wilderbuer, T.K., and G.E. Walters. 1997. Rock sole. Pp. 245-270 *in* Stock Assessment and Fishery
41 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
42 Projected for 1998. Bering Sea/Aleutian Islands Plan Team (eds.). North Pacific Fishery
43 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
44
- 45 Wilderbuer, T.K., and G.E. Walters. 1992. Rock sole. *in* Stock Assessment and Fishery Evaluation
46 Report for the Groundfish Resources of the Bering Sea and Aleutian Islands Regions as
47 Projected for 1993. Bering Sea and Aleutian Islands Plan Team (eds.). North Pacific Fishery
48 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
49
- 50 Wilderbuer, T.K., and G.E. Walters. 1999. Rock sole. *In* Stock Assessment and Fishery Evaluation

1 Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. Bering
2 Sea/Aleutian Islands Plan Team, pp. 349-390. (North Pacific Fishery Management Council, 605
3 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
4

5 Wilderbuer, T.K., G.E. Walters, and R.G. Bakkala, R. G. 1992. Yellowfin sole, *Pleuronectes asper*, of
6 the Eastern Bering Sea: Biological Characteristics History of Exploitation, and Management.
7 Mar. Fish. Rev. 54:1-18.
8

9 Wiley, D.N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon.1995. Stranding and mortality of
10 humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States,
11 1985-1992. Fish. Bull., U.S. 93:196-205.
12

13 Wilke, F., and K.W. Kenyon. 1952. Notes on the Food of Fur Seal, Sea-Lion and Harbor Porpoise. J. of
14 Wildl. Management 16:396-397.
15

16 Winn, H. E., C. A. Price, and P. W. Sorensen. 1986. The distributional biology of the right whale
17 (*Eubalaena glacialis*) in the western North Atlantic. Rep. Int. Whal. Comm. Spec. Iss. 10:129-
18 138.
19

20 Witherell, D., and Harrington, G. 1996. Evaluation of Alternative Management Measures to Reduce the
21 Impacts of Trawling and Dredging on Bering Sea Crab Stocks. *In* High Latitude Crabs: Biology,
22 Management, and Economics. Alaska Sea Grant Report, AK-SG-96-02, Alaska Sea Grant
23 Program, 304 Eielson Building, University of Alaska Fairbanks, Fairbanks, AK 99775. pp. 41-
24 58.
25

26 Witherell, D., and J.N. Ianelli. 1997. A guide to stock assessment of Bering Sea and Aleutian Islands
27 groundfish. North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
28 Anchorage, AK 99501.
29

30 Witherell, D., and Pautzke, C. 1997. A brief history of bycatch management measures for eastern
31 Bering Sea groundfish fisheries. Marine Fisheries Review, 59:15-22.
32

33 Whittaker, R.H. and C.W. Fairbanks. 1958. A study of plankton copepod communities in the Columbia
34 Basin, southeastern Washington. Ecology 39: 46-65.
35

36 Wolfe, R.J., and L.B. Hutchinson-Scarborough. 1996. The subsistence harvest of harbor seal and sea lion
37 by Alaska natives in 1998. Final report for year seven, subsistence study and monitor system
38 (no. 50ABNF400080). Prepared for the NMFS by Alaska Dept. Fish and Game, Juneau, Alaska,
39 72 pp. + appendices.
40

41 Wolfe, R.J., and C. Mishler. 1993. The subsistence harvest of harbor seal and sea lion by Alaska natives
42 in 1992. Final report for year one, subsistence study and monitor system (no. 50ABNF20055).
43 Prepared for the NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 94 pp. + appendices.
44

45 Wolfe, R.J., and C. Mishler. 1994. The subsistence harvest of harbor seal and sea lion by Alaska natives
46 in 1993. Final report for year two, subsistence study and monitor system (no. 50ABNF20055).
47 Prepared for the NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 60 pp. + appendices.
48

49 Wolfe, R.J., and C. Mishler. 1995. The subsistence harvest of harbor seal and sea lion by Alaska natives
50 in 1994. Final report for year three, subsistence study and monitor system (no. 50ABNF20055).

- 1 Prepared for the NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.
2
- 3 Wolfe, R.J., and C. Mishler. 1996. The subsistence harvest of harbor seal and sea lion by Alaska natives
4 in 1995. Final report for year four, subsistence study and monitor system (no. 50ABNF400080).
5 Prepared for the NMFS by Alaska Dept. Fish and Game, Juneau, Alaska, 69 pp. + appendices.
6
- 7 Wolotira, R.J.J., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions
8 for many commercially important fishes and shellfishes off the west coast of North America,
9 based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commer., NOAA
10 Tech. Memo. NMFS-AFSC-6. 184 pp.
11
- 12 Woodby, Douglas A., and D. B. Botkin. 1993. Stock Sizes Prior to Commercial Whaling. *In: The*
13 *Bowhead Whale.* J.J. Burns, J.J. Montague, C.J. Cowles, (Eds). The Society for Marine
14 Mammalogy. Special Publication Number 2. Lawrence: Allen Press, Inc., 764.
15
- 16 Wyllie-Echeverria, T., and W.S. Wooster. 1998. Year-to-year variations in Bering Sea ice cover and
17 some consequences for fish distributions. *Fish. Oceanogr.* 7:159-170.
18
- 19 Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in
20 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.
21
- 22 Yang, M.S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S.
23 Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60. 105 pp.
24
- 25 Yochem, P.K., and S. Leatherwood. 1985. Blue whale *Balaenoptera musculus* (Linnaeus, 1758). Pp.
26 193-240 in Ridgway, S.H. and R. Harrison (eds.), *Handbook of Marine Mammals*, vol. 3: The
27 Sirenians and Baleen Whales. Academic Press, London. 362 pp.
28
- 29 York, A.E. 1994. The population dynamics of northern sea lions 1975-85. *Mar. Mamm. Sci* 10:38-51.
30
- 31 York, A.E., R.L. Merrick, and T.R. Loughlin. 1996. An analysis of the Steller sea lion metapopulation
32 in Alaska. Pp. 259-292 in D.R. McCullough (ed.), *Metapopulations and Wildlife Conservation*,
33 Island Press, Washington, D.C.
34
- 35 Zeh, J.E., C. W. Clark, J. C. George, D. Withrow, G. M. Carroll, and W. R. Koski. Current Population
36 Size and Dynamics. *In: The Bowhead Whale.* J.J. Burns, J.J. Montague, C.J. Cowles, (Eds). The
37 Society for Marine Mammalogy. Special Publication Number 2. Lawrence: Allen Press, Inc.,
38 1993. 764.
39
- 40 Zemsky, V., A. A. Berzin, Y. A. Mikhailiev, and D. D. Tormosov. 1995. Soviet Antarctic pelagic whaling
41 after WWII: Review of actual catch data. Report of the Sub-committee on Southern
42 hemisphere baleen whales. *Rep. Int. Whal.Comm.* 45:131-135.
43
- 44 Zhang, C.I. 1987. Biology and Population Dynamics of Alaska plaice, *Pleuronectes quadrierculatus*, in
45 the Eastern Bering Sea. Ph.D. University of Washington, 3707 Brooklyn Avenue, Seattle, WA
46 98195, 225 pp.
47
- 48 Zimmermann, M. 1997. Maturity and fecundity of arrowtooth flounder, *Atheresthes stomias*, from the
49 Gulf of Alaska. *Fish. Bull.* 95:598-611.
50

- 1 Zolotov, O.G. 1993. Notes on the reproductive biology of *Pleurogrammus monopterygius* in
2 Kamchatkan waters. J. of Ichthy. 33:25-37.
3
4 Zug, G.R. 1990. Age determination for long-lived reptiles: some techniques for sea turtles. Annales des
5 Sciences Naturelles, Zoologie, Paris. 13e Serie 11: 219-222.

INDEX OF ABBREVIATIONS

1				
2				
3	ABC	Acceptable Biological Catch	FR	Final Rule
4	ADF&G	Alaska Department of Fish and	FRFA	Final Regulatory Flexibility
5		Game		Analysis
6	AFSC	Alaska Fisheries Science Center	FSEIS	Final Supplemental EIS
7	AFA	American Fisheries Act	GOA	Gulf of Alaska
8	AI	Aleutian Islands	IFQ	Individual Fishing Quota
9	AP	Advisory Panel to the NPFMC	INPFC	International North Pacific
10	BSAI	Bering Sea and Aleutian Islands		Fisheries Commission
11	BSC	Bering Slope Current	IPHC	International Pacific Halibut
12	CCAMLR	Commission for the		Commission
13		Conservation of Antarctic	IRFA	Initial Regulatory Flexibility
14		Marine Living Resources		Act
15	CCS	California Current System	IWC	International Whaling
16	CDQ	Community Development		Commission
17		Quota	JVP	Joint Venture Processing
18	CFR	Code of Federal Regulations	LLP	License Limitation Program
19	CH	Critical Habitat	LOA	Length Overall
20	CH-RFRPA	Combined CH and other	M	Natural Mortality Rate
21		haulouts	MMPA Marine	Mammal Protection Act
22	CPUE	Catch Per Unit Effort	MSA	Magnuson-Stevens Fishery
23	CVOA	Catcher Vessel Operational		Conservation and Management
24		Area		Act
25	DAH	Domestic Annual Harvest	MSY	Maximum Sustainable Yield
26	DAP	Domestic Annual Processing	mt	Metric Ton
27	DSEIS	Draft Supplemental	NEPA	National Environmental Policy
28		Environmental Impact		Act
29		Statement	NMFS	National Marine Fisheries
30	DSR	Demersal Shelf Rockfish		Service
31	EA	Environmental Assessment	NMML	National Marine Mammal Laboratory
32	EBS	Eastern Bering Sea	NOA	Notice of Availability
33	EEZ	Exclusive Economic Zone	NOAA	National Oceanic and
34	EFP	Exempted Fishing Permit		Atmospheric Administration
35	EIR	Economic Impact Review	NPAFC	North Pacific Anadromous Fisheries
36	EIS	Environmental Impact		Commission
37		Statement	NPFMC	North Pacific Fishery
38	EIT	Echo Integration Trawl		Management Council
39	ENSO	El Nino/Southern Oscillation	OFL	Overfishing Level
40	EPA	Environmental Protection	OPR	NMFS Office of Protected
41	ESA	Endangered Species Act		Resources
42	ESU	Evolutionary Significant Unit	OSF	NMFS Office of Sustainable
43	F	Fishing Mortality Rate		Fisheries
44	FMP	Fishery Management Plan	OY	Optimum Yield
45	FO	Frequency of Occurrence	PDF	Probability Density Factor
46	FOCI	Fisheries Oceanography	PDO	Pacific Decadal Oscillations
47		Coordinated Investigations	POP	Pacific Ocean Perch
48			PR	Proposed Rule
49	FONSI	Finding of No Significant	PSC	Prohibited Species Catch
50		Impact	PWS	Prince William Sound

1	RFRPA	Revised Final Reasonable and Prudent
2		Alternatives
3	RPA	Reasonable and Prudent
4		Alternative(s)
5	RIR	Regulatory Impact Review
6	RKCSA	Red King Crab Savings Area
7	SAFE	Stock Assessment and Fishery
8		Evaluation
9	SEIS	Supplemental Environmental
10		Impact Statement
11	SPR	Spawning Per Recruit
12	SSC	Scientific and Statistical
13		Committee to the NPFMC
14	TAC	Total Allowable Catch
15	TALFF	Total Allowable Level of Foreign
16		Fishing
17	USFWS	U.S. Fish and Wildlife Service
18		

APPENDIX 1 CONTENTS OF THE BSAI AND GOA FMPS

1 This appendix provides a synopsis of the contents of

2
3 (1) the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish, and

4
5 (2) the Fishery Management Plan for Groundfish of the Gulf of Alaska.

6 7 **Bering Sea/Aleutian Islands**

8
9 The Fishery Management Plan (FMP) for the Bering Sea/Aleutian Islands (BSAI) consists of the
10 following sections and information.

11
12 1.0 Summary Sheet---The summary sheet is administrative and is used to identify the document as the
13 Final Environmental Impact Statement for the implementation of the groundfish fishery in the BSAI area
14 under the MSA. The summary describes the environmental impacts of the groundfish fishery as follows
15 (p. 1).

16
17 Implementation of this fishery management plan within the limit of its constraints is presumed
18 not to cause adverse impacts on the environment. Conservation measures are provided for
19 species for which they are deemed necessary. Those measures and the conduct of the fishery as
20 outlined will be beneficial to the ocean environment affected, to demersal and pelagic fishes and
21 to the human environment.

22
23 The summary sheet also includes a listing of the FMP amendments through amendment 59, implemented
24 January 25, 1999.

25
26 2.0 Executive Summary---This section lists the management objectives to be attained (see section 2.2.1
27 above), and a summary of the ecological, economic, and social impacts of the plan. Under ecological
28 impacts, the executive summary states the following (p. 13).

29
30 In the context of long-term relationships, fishery managers are just now beginning to find out,
31 understand and quantify the complex relations among species and between biota and the
32 environment of the ecosystem in the Bering Sea/Aleutian Islands area. Until that understanding
33 is more fully developed, it is not possible to predict the long-term effect on the ecosystem of the
34 current, single-species management strategies (as opposed to the integrated ecosystem method)
35 or of subtle environmental changes....

36
37 It is generally recognized by fisheries scientists that the existing theories and models pertaining
38 to fishery resources management suffer some fundamental inadequacies; concepts and theories
39 must be developed to answer present and future management decisions. Until such new concepts
40 supercede the old, the latter can still serve as a useful basis for deriving management decisions,
41 providing their limited and underlying assumptions are recognized and evaluated with the best
42 available information. This is the philosophy and approach used throughout this plan.

1 3.0 Introduction to the Plan---The introduction explains that this plan replaced the preceding Preliminary
2 Fishery Management Plan for the Trawl and herring Gillnet Fisheries of the Bering Sea and Aleutians.
3 The introduction also describes the geographic area covered by the plan, and the goals and secondary
4 objectives for the plan (see section 2.2.1). Finally, the introduction provides operational definitions of
5 terms, including overfishing and the six-tier system for setting catch targets and limits.
6

7 4.0 Description of the Fishery---This section begins with a more detailed description of the geographic
8 areas involved or potentially affected by the BSAI groundfish fishery, and then provides a brief overview
9 of the species and stocks taken in the fishery. The remainder of the section describes the history of
10 exploitation, with emphasis on the foreign fisheries.
11

12 5.0 History of Management---The measures used to manage the historical fishery (both domestic and
13 foreign) are described, together with their purposes and effectiveness.
14

15 6.0 History of Research---This section provides an overview of research conducted by the U.S. and
16 foreign scientists prior to the implementation of the plan.
17

18 7.0 Socioeconomic Characteristics of the Domestic Fishery---The socio-economics of the fishery prior to
19 the implementation of the plan are described in this section.
20

21 8.0 Biological and Environmental Characteristics of the Fishery---This section begins with brief
22 summaries of the target and other species, the fisheries, and limited trophic, habitat, and life history data
23 on each species or species complex. The section then continues with dated summaries of stock units,
24 data sources for catch per unit effort and other biological data, quality of data, ecological relationships,
25 environmental characteristics of the affected area, biological characteristics of the Bering Sea, and
26 ecosystem characteristics of the Bering Sea. The FMP includes in this section two figures illustrating the
27 relations between age and numbers and biomass of pollock (FMP Fig. 21, reproduced here as Fig. 2.1),
28 and the relations between age and biomass of pollock as consumed by fish and birds, consumed by
29 marine mammals, removed by the fishery, and removed by natural mortality (FMP Fig. 22, reproduced
30 here as Fig. 2.2). The section then continues with a section on status of the stocks (which is more a
31 discussion of the allowable biological catch [ABC], maximum sustainable yield [MSY], and optimum
32 yield [OY]) and then a description of the overall condition of the stocks. This section then ends with a
33 description of habitat types, essential fish habitat for BSAI groundfish, fishing and non-fishing activities
34 that may affect essential fish habitat, habitat conservation recommendations for fishing and non-fishing
35 activities, prey species as a component of EFH, habitat areas of particular concern, and review and
36 revision of essential fish habitat components of the FMP.
37

38 9.0 Other Considerations Which May Affect the Fishery---This section begins with a brief discussion of
39 the potential conflict that could arise as a result of halibut bycatch in the groundfish fisheries. Next, the
40 implications of the Marine Mammal Protection Act are described. In this section, the plan states the
41 following (p. 275-277).
42

43 “... this FMP is cognizant of the ecosystem and mammal population requirements. As reported in
44 an earlier section on “Ecosystem Characteristics,” a dynamic numerical marine ecosystem
45 mode[1] is currently in use to study ecosystem interactions, including those by marine mammals.
46 The Plan Development Team of this FMP is acutely aware and is striving for an “ecosystem
47 approach” for managing the marine resources. It will, however, be some time (3-5 years) before
48 an appropriate ecosystem model has become far enough developed, and empirically tested, to

1 begin to be relied upon for resource management. Until that time, single species models will be
2 applied to the fishery resources, but in a manner that will retain balance among the various fish
3 components, be generally conservative, and be determined to be not detrimental to current
4 marine mammal populations. The manner in which MSY, EY, and ABC were derived for each
5 fish stock in Annex I has indirectly taken into consideration the volume of fish needed by marine
6 mammals for their sustenance. For example natural mortality of fish stocks is taken into
7 consideration in stock assessments and in its present application, includes the predation
8 component by marine mammals.... Although specific ranges of optimum sustainable population
9 have not been clearly determined for these [marine mammal] species, the impact of fisheries can
10 be inferred from marine mammal population trends.... Of the seven species [of pinnipeds], the
11 sea lions and fur seals might be significantly affected by groundfish harvest levels. ...[A] 50%
12 decline in sea lion population has been noted since the late 1950s in the eastern Aleutian Islands.
13 The factors that may have caused this decline are not certain but probably include (1) a westward
14 shift in distribution since population abundance to the western Aleutians appears to be high; (2)
15 commercial fisheries interaction since groundfish (primarily pollock) forms a significant portion
16 of their diet; (3) disease such as leptospirosis; and (4) other unknown population control factors.
17 This decline in abundance is of concern and should be watched more closely. The proposed total
18 groundfish OY for 1980 for the Aleutians region is below past catch levels and if the abundance
19 of fish is limiting for sea lions in this region, this FMP should leave more fish for sea lion
20 consumption.... Although direct competition for food fish is one of many factors that affect
21 marine mammal populations, the other factors are not readily quantifiable. Some of these
22 mammals may be sensitive to disturbances created by fishing activities and may leave the area
23 under such harassments.

24
25 With reference to the Endangered Species Act, the FMP simply states (p. 277) that

26
27 The Federal action proposed in this fishery management plan is not likely to jeopardize the
28 continued existence of endangered or threatened species, or result in the destruction or
29 modification of habitat critical to those species.

30
31 The remainder of this section briefly describes the potential effects of activities related and unrelated to
32 fishing activities, including the potential for habitat alteration, offshore petroleum production, coastal
33 development and filling, marine mining, ocean discharge and dumping, derelict fragments of fishing gear
34 and general litter, and benthic habitat damage by bottom gear. The section ends with a bio-economic
35 factors with an example of cohort analysis for pollock, and a description of the crab-bait trawl fishery.

36
37 10.0 Optimum Yield (OY) and Total Allowable Catch (TAC)---This section describes MSY and OY for
38 the groundfish complex, TACs, requirements of the Stock Assessment and Fishery Evaluation reports,
39 the use of reserves set aside to ensure catches are consistent with quotas, and apportionments to the
40 fishery.

41
42 11.0 Catch and Capacity Descriptors---This is a dated section on catch and processing capacity as the
43 plan was being developed.

44
45 12.0 Allocations between Foreign and Domestic Fishermen---This section describes past allocation of
46 quotas between foreign and domestic sectors of the fishery.

47
48 13.0 Management Regime---The majority of information on management of the BSAI groundfish

1 fisheries is included in this section. Objectives are listed first (see section 2.2.1 above), followed by a
2 description of management areas within the BSAI region. BSAI species are then listed in five categories:
3 prohibited, target, other, forage fish, and nonspecified. The fishing year is defined and criteria for
4 establishing seasons are listed. Management measures for the domestic fishery are described next,
5 including prohibited species, time/area closures and catch limits for prohibited species. These measures
6 also include fishing area restrictions, and a section on marine mammal conservation measures, which
7 states the following (p. 308-309).

8
9 Regulations implementing the FMP may include special groundfish management measures
10 intended to afford species of marine mammals additional protection other than that provided by
11 other legislation. These regulations may be especially necessary when marine mammal species
12 are reduced in abundance. For example, Steller sea lions are so reduced in abundance that they
13 have been listed as threatened within the meaning of the Endangered Species Act. Even absent
14 such a listing, regulations may be necessary to prevent interactions between commercial fishing
15 operations and marine mammal populations when information indicates that such interactions
16 may adversely affect marine mammals, resulting in reduced abundance and /or reduced use of
17 areas important to marine mammals. These areas include breeding and nursery grounds, haul out
18 sites, and foraging areas that are important to adult and juvenile marine mammals during
19 sensitive life stages.

20
21 Regulations intended to protect marine mammals might include those that would limit fishing
22 effort, both temporarily [sic], spatially, around areas important to marine mammals. Examples of
23 temporal measures are seasonal apportionments of TAC specifications. Examples of spatial
24 measures could be closures around areas important to marine mammals. The purpose of limiting
25 fishing effort would be to prevent harvesting excessive amounts of the available TAC or seasonal
26 apportionments thereof at any one time or in any one area.

27
28 Areas closed to trawling are listed next, followed by gear restrictions. Reporting requirements and the
29 observer program are described, followed by a description of effort-limiting programs including fixed-
30 gear sablefish fisheries, the moratorium on the fisheries through 1999, the license limitation program
31 initiated in 2000, and the Community Development Quota (CDQ) program. The need and mechanisms
32 for inseason adjustments of the fisheries are explained, followed by a description of catch allocation by
33 gear types for the different fisheries. The inshore/offshore allocation of pollock is described next, but the
34 FMP notes that this information has been superseded by the American Fisheries Act of 1998.
35 Experimental fishing permits are described, followed by a dated description of the management measures
36 for the foreign fisheries. This section ends with a list of operational needs and costs, management
37 measures to address identified habitat problems, measures to allow gear testing, and the improved
38 retention/improved utilization program.

39
40 14.0 Relationship of Recommended Management Measures to FCMA National Standards and Other
41 Applicable Law---This section is a dated description of the relation of the FMP to other federal and state
42 laws.

43
44 15.0 Research Needs---This section lists and describes areas in need of research (p. 351).

45
46 Research will be required to: (1) find means of improving the accuracy of commercial catch
47 statistics; (2) refine estimates of abundance and biological characteristics of stocks through
48 research resource surveys; (3) improve the capability for predicting changes in resources

1 abundance, composition, and availability; (4) develop means of reducing the incidental catch of
2 non-target species; (5) identify subpopulations; and (6) examine the direct effects of man's
3 activities on fish habitats and ecosystems.
4

5 With respect to the sixth point, this section also states the following (p. 352).
6

7 Research needs related to maintaining the productive capacity of fish habitat can be broadly
8 classified as those which (a) examine the direct affects of man's activities (such as fishing, oil
9 exploration, or coastal development), and (b) apply fisheries oceanography in an ecosystem
10 context (such as migration and transport patterns, predator/prey relationships, life histories).
11 Both categories of research serve to increase the understanding of natural systems and the ability
12 to detect and measure change caused by natural or man-made forces.
13

14 16.0 Statement of Council Intentions to Review the Plan after Approval by the Secretary of Commerce---
15 This section is a statement that following implementation of the plan, the Council will maintain a
16 continuing review of the fisheries managed under this plan through four methods.¹
17

18 17.0 References---This section is self explanatory.
19

20 18.0 Appendices and Annexes---Appendix I is a Sample Community Profile. Appendix II is an example
21 of a Pollock Cohort Analysis. Appendix III is a description of Closed Areas. Appendix IV describes
22 Programs Addressing Habitat of Bering Sea/Aleutian Islands Groundfish Stocks. Annex I describes the
23 Content of Stock Assessment and Fishery Evaluation Reports. Annex II describes the Derivation of
24 Total Allowable Level of Foreign Fishing (TALFF). Annex III provides three tables of Catch Statistics
25 of the Bering Sea/Aleutian Groundfish Fishery. Annex IV provides Information on Marine Mammal
26 Population.² Annex IV then provides brief overviews of the Steller (northern) sea lion, northern fur seal,

¹ The four methods listed are the following.

1. Maintain close liaison with the management agencies involved, usually the Alaska Department of Fish and Game and the National Marine Fisheries Service, to monitor the development of the fisheries and the activity in the fisheries.
2. Promote research to increase their knowledge of the fishery and the resource, either through Council funding or by recommending research projects to other agencies.
3. Conduct public hearings at appropriate times and in appropriate locations, usually at the close of a fishing season and in those areas where a fishery is concentrated, to hear testimony on the effectiveness of the management plans and requests for changes.
4. Consideration of all information gained from the above activities and development if necessary, of amendments to the management plan. The Council will also hold public hearings on proposed amendments prior to forwarding them to the Secretary for possible adoption.

² Annex IV states the following. "Information on distribution and migration, abundance and trends, feeding habits, and any problems induced by fisheries on seven marine mammal populations in the Bering Sea/Aleutian Region was provided by the Marine Mammal Division of the Northwest and Alaska Fisheries Center and included in this annex, the information [is] summarized mainly from the annual report of the Department of Commerce on the Administrati[on] of the Marine Mammal Protection

1 and bearded, ringed, harbor, larga, and ribbon seals. Annex V lists literature cited. Annex VI lists
2 species categories for the BSAI groundfish fishery. Finally, Annex VII describes Information on
3 Important Habitat for Non-FMP Species Pacific Halibut and Pacific Herring.

4 **Gulf of Alaska**

5
6
7 The Fishery Management Plan (FMP) for the Gulf of Alaska (GOA) consists of the following sections
8 and information.

9
10 1.0 Introduction---The introduction gives general background on the FMP. With respect to
11 environmental affects, the introduction states (p. 1) that the FMP “forms the major component of an
12 Environmental Impact Statement which assesses the effect that implementation of this plan is expected to
13 have on the environment of the region which encompasses the Gulf of Alaska.”

14
15 2.0 Goals and Objectives---The goals and objectives of the plan are listed (as listed in 2.2.1 above),
16 together with a section on operational definition of terms. The tier system for setting catch limits is
17 described under the definition of overfishing.

18
19 3.0 Areas and Stocks Involved---The geographic area of the GOA groundfish fishery is described,
20 together with listings of target stocks, prohibited stocks, forage fish, and other species.

21
22 4.0 Management Measures---This section is divided into three areas: framework measures, conventional
23 measures, and other measures. Framework measures include the procedures for setting the TAC, the
24 optimum yield range, the Stock Assessment and Fishery Evaluation Reports, setting of reserves (to
25 prevent fisheries from exceeding quotas), prohibited species catch limits and incentives to reduce halibut
26 bycatch, in-season adjustment of time and area, and time/area closures. Conventional measures describe
27 permit requirements, general restrictions (catch, processing, gear), recordkeeping and reporting
28 requirements, gear allocations, experimental fishing permits, inshore/offshore allocation of pollock and
29 Pacific cod, fishing seasons, observers, habitat protection, and vessel safety considerations. Other
30 measures pertain to access limitation for fixed sablefish fisheries, the (past) moratorium on vessels
31 entering the fisheries, and the new groundfish license limitation program, size limits, gear testing, marine
32 mammal conservation measures, and the improved retention/improved utilization program. The
33 statement on marine mammal conservation measures (p. 50) is the same as provided in section 13.0 of the
34 BSAI FMP.

35
36 5.0 Information on the Fishery and Resources---This section begins with a description of the biological
37 and environmental characteristics of the resource species, including habitat requirements by life history
38 stage, status of stocks, and a brief description of the habitat types in the GOA. The next part of this
39 section describes the fisheries (domestic and foreign [which no longer exists]), the socioeconomic
40 characteristics of the resources and fisheries, interactions between and among user groups, relationship of
41 the management plan to other existing laws and policies, enforcement requirements, financing
42 requirements, references, essential fish habitat for GOA groundfish, and information on important habitat
43 for non-FMP species including Pacific halibut and GOA crab species.

Act of 1972 for the period of April 1, 1977 through March 31, 1978 (DOC, 1978) and the Final
Environmental Impact Statement on Consideration of a Waiver of the Moratorium and Return of
Management of Certain Marine Mammals to the State of Alaska, Volumes I and II (DOC and DOI,
1977.)”

APPENDIX 2 TARGET SPECIES AND FISHERIES

1 This appendix presents descriptions of major target species summarizing important life history traits,
2 trophic interactions, habitat, stock assessment, and status. Additional information is available in the 2000
3 Stock Assessment and Fishery Evaluation reports, available from the North Pacific Fishery Management
4 Council (605 West 4th, Suite 306, Anchorage, Alaska 99501-2252)

5 6 **Pollock**

7 8 *Stock Description and Life History*

9
10 Pollock (*Theragra chalcogramma*) is the most abundant species within the eastern Bering Sea (EBS) and
11 the second most abundant groundfish stock in the Gulf of Alaska (GOA). It is widely distributed
12 throughout the North Pacific in temperate and subarctic waters (Wolotira et al. 1993). Pollock is a
13 semidemersal schooling fish, which becomes increasingly demersal with age. Approximately 50 percent
14 of female pollock reach maturity at age four, at a length of approximately 40 cm. Pollock spawning is
15 pelagic and takes place in the early spring on the outer continental shelf. In the EBS, the largest
16 concentrations occur in the southeastern area north of Unimak Pass. In the GOA, the largest spawning
17 concentrations occur in Shelikof Strait and the Shumagin Islands (Kendall et al. 1996). Juvenile pollock
18 are pelagic and feed primarily on copepods and euphausiids. As they age, pollock become increasingly
19 piscivorous and can be highly cannibalistic, with smaller pollock being a major food item (Livingston
20 1991b). Pollock are comparatively short lived, with a fairly high natural mortality rate estimated at 0.3
21 (Hollowed et al. 1997, Wespestad and Terry 1984) and maximum recorded age of around 22 years.

22
23 Although stock structure of Bering Sea pollock is not well defined (Wespestad 1993), three stocks of
24 pollock are recognized in the BSAI for management purposes: EBS, Aleutian Islands and Aleutian Basin
25 (Wespestad et al. 1997b). Pollock in the GOA are thought to be a single stock (Alton and Megrey 1986)
26 originating from springtime spawning in Shelikof Strait (Brodeur and Wilson 1996).

27 28 *The Fishery*

29
30 Pollock supports the largest fishery in Alaskan waters. In the Bering Sea/Aleutian Islands region (BSAI),
31 pollock comprise 75-80 percent of the catch. In the GOA, pollock constitute 25-50 percent of the catch.
32 In the BSAI, pollock can only be targeted with pelagic trawl gear to minimize the potential interaction
33 with other groundfish species and to reduce the magnitude of bottom disturbance. Pollock are also caught
34 with bottom-trawl gear as bycatch from other fisheries.

35
36 In the BSAI, the season has traditionally been broken into two parts, a roe season during early winter,
37 and a surimi (imitation crab)/filet season during the second half of the year. Currently, to minimize the
38 potential indirect interaction with Steller sea lions (*Eumetopias jubatus*), the seasons have been managed
39 to occur over broader areas and over seasons that are less contracted in time.

40
41 BSAI pollock are caught as bycatch in other directed fisheries but because they occur primarily in well
42 defined aggregations, the impact of this bycatch is typically minimal. Discard rates through the early
43 1990s (discards/retained catch) of pollock in the directed fishery have been about 7-8 percent but in 1998

1 dropped to 1.5 percent (Ianelli et al. 1999). This is due to the fact that in 1998, discarding of pollock was
2 prohibited except in the fisheries where pollock are in bycatch-only status. Pollock are caught as bycatch
3 in the trawl Pacific cod, rock sole, and yellowfin sole fisheries.
4

5 In the GOA, major exploitable concentrations are found primarily in the central and western regulatory
6 areas (147° - 170° W). Pollock from this region are managed as a single stock that is separate from the
7 BSAI pollock stocks (Alton and Megrey 1986). The pattern of the fishery generally reflects the broad
8 spatial distribution of pollock throughout the Central and Western regions of the GOA. Concentrations of
9 pollock shift to reflect the seasonal migrations to spawning locations. The fishery generally occurs at
10 depths between 100 and 200 m (Hollowed et al. 1997). Important pollock fishery locations include
11 Shelikof Strait, the canyon regions of the east side of Kodiak Island, and Shumagin Canyon.
12

13 Megrey (1989) documented the historical expansion of the pollock fishery in the GOA. He identified
14 four phases of expansion, beginning with a developmental phase between 1964-1971 when the fishery
15 was dominated by foreign trawlers that captured pollock incidentally in mixed species catches. The
16 second phase occurred between 1972 and 1980 when directed pollock harvests were initiated by foreign
17 and joint venture fisheries. Floating freezer-surimi trawlers were active in the GOA during the second
18 phase of fishery development. The third phase of development occurred between 1981- 1985. This phase
19 was characterized by joint venture operations. During this period, the Shelikof Strait spawning
20 concentrations were discovered. Surimi production and roe harvest were emphasized during this phase of
21 development. Foreign vessels were eliminated from the pollock fishery in the late 1980s. This phase was
22 marked by the passage of the in-shore/off-shore amendment which mandated that 100 percent of the
23 pollock catch would be processed at shoreside plants. During this period the fishing community moved
24 from a bottom trawl fishery to a mid-water fishery due to management measures established to control
25 bycatch of prohibited species. Pacific halibut (*Hippoglossus stenolepis*) taken in the pollock fishery are
26 added to the total for the shallow water complex halibut mortality cap. When the halibut cap is reached
27 for the shallow water complex, trawling for species in the complex is prohibited except for vessels using
28 pelagic trawls.
29

30 *Trophic Interactions*

31

32 The diet of pollock in the EBS has been studied extensively (Dwyer 1984, Lang and Livingston 1996,
33 Livingston 1991b, Livingston and DeReynier 1996, Livingston et al. 1993). These studies have shown
34 that juvenile pollock is the dominant fish prey in the EBS; other fish are also consumed by pollock
35 including juveniles of Pacific herring, Pacific cod, arrowtooth flounder, flathead sole, rock sole,
36 yellowfin sole, Greenland turbot, Pacific halibut and Alaska plaice. On the shelf area of the EBS, the
37 contribution of these other fish prey to the diet of pollock tends to be very low (i.e., usually less than 2
38 percent by weight of the diet; (Livingston 1991b, Livingston and DeReynier 1996, Livingston et al.
39 1993). However, in the deeper slope waters, deep-sea fish (myctophids and bathylagids) are a relatively
40 important diet component (12 percent by weight), along with euphausiids, pollock, pandalid shrimp and
41 squid (Lang and Livingston 1996).
42

43 The cannibalistic nature of pollock, particularly adults feeding on juveniles, is well-documented by field
44 studies in the EBS (Bailey 1989, Dwyer et al. 1987, Livingston 1989b, 1991b, Livingston and DeReynier
45 1996, Livingston and Lang 1997, Livingston et al. 1993). As mentioned previously, cannibalism by
46 pollock in the Aleutian Islands region has not yet been documented (Yang 1996).
47

48 Cannibalism rates in the EBS vary depending on year, season, area, and predator size (Dwyer et al. 1987,

1 Livingston 1989b, Livingston and Lang 1997). Cannibalism rates are highest in autumn, next highest in
2 summer, and lowest in spring. Cannibalism rates by pollock larger than 40cm are higher than those by
3 pollock less than 40cm. Most pollock cannibalized are age-0 and age-1 fish, with most age-1 pollock
4 being consumed northwest of the Pribilof Islands where most age-1 pollock are found. Pollock larger
5 than 50 cm tend to consume most of the age-1 fish. Smaller pollock consume mostly age-0 fish. Although
6 age-2 and age-3 pollock are sometimes cannibalized, the frequency of occurrence of these age groups in
7 the stomach contents is quite low. Laboratory studies have shown the possibility of cannibalism among
8 age-0 pollock (Sogard and Olla 1993). Field samples have confirmed this interaction, but so far this
9 interaction appears not to be very important.

10
11 Field and laboratory studies on juvenile pollock have examined behavioral and physical factors that may
12 influence vulnerability of juveniles to cannibalism (Bailey 1989, Olla et al. 1995, Sogard and Olla 1993,
13 1996). Although it had previously been hypothesized that cannibalism occurred only in areas with no
14 thermal stratification, these recent studies show that age-0 pollock do move below the thermocline into
15 waters inhabited by adults. Larger age-0 fish tend to move below the thermocline during the day, and all
16 age-0 fish tend to inhabit surface waters at night for feeding. Most cannibalism may occur during the day.
17 If food availability is high, all sizes tend to stay above the thermocline, but when food resources are low
18 then even small age-0 fish do move towards the colder waters as an energy-conserving mechanism. Thus,
19 prediction of cannibalism rates may require knowledge of the thermal gradient and food availability to
20 juveniles in an area.

21
22 Various studies have modeled pollock cannibalism in either a static or dynamic fashion (Dwyer 1984,
23 Honkalehto 1989, Knechtel and Bledsoe 1981, 1983, Laevastu and Larkins 1981, Livingston 1991a,
24 1994, Livingston et al. 1993). The Knechtel and Bledsoe (1983) size-structured simulations produced
25 several conclusions regarding cannibalism. Under conditions simulating the current fishing mortality rate
26 ($F=0.3\text{yr}^{-1}$) the population tended toward equilibrium. They also found that cannibalism is a stabilizing
27 influence, with the population showing less variation compared to simulations in which cannibalism was
28 not included. Zooplankton populations were also simulated in the model, and Knechtel and Bledsoe
29 concluded that food was limiting, particularly for adult pollock. Maximization of average catch occurred
30 at an extremely high F value ($F=3.0\text{ yr}^{-1}$) that is about ten times higher than the actual fishing mortality
31 rates in the EBS. However, the interannual variation in catches under this hypothetical scenario were
32 extremely large.

33
34 The trend in more recent modeling efforts (Honkalehto 1989, Livingston 1993, 1994) has been to
35 examine cannibalism using more standard stock assessment procedures such as virtual population
36 analysis or integrated catch-age models such as Methot's (1990) synthesis model. The purpose is to
37 obtain better estimates of juvenile pollock abundance and mortality rates, which can improve our
38 knowledge of factors affecting recruitment of pollock into the commercial fishery at age 3. Results from
39 Livingston (1993, 1994) highlight several points with regard to cannibalism. In the current state of the
40 EBS, cannibalism appears to be the most important source of predation mortality for age-0 and age-1
41 pollock. Predation mortality rates for juvenile pollock are not constant, as assumed in most population
42 assessment models, but vary across time mainly due to changes in predator abundance but perhaps also
43 due to predators feeding more heavily on more abundant year classes. The decline in pollock recruitment
44 observed at high pollock spawning biomasses appears to be due to cannibalism. There also appears to be
45 an environmental component to juvenile pollock survival (Wespestad et al. 1997a), wherein surface
46 currents during the first 3 months of life may transport larvae to areas more favorable to survival (e.g.,
47 away from adult predators or in areas more favorable for feeding). Estimates of total amount of pollock
48 consumed by important groundfish predators show that cannibalism is the largest source of removal of

1 juvenile pollock by groundfish predation (Livingston 1991a, Livingston and DeReynier 1996, Livingston
2 et al. 1993).

3
4 Other groundfish predators of pollock include Greenland turbot, arrowtooth flounder, Pacific cod, Pacific
5 halibut, and flathead sole (Livingston 1991a, Livingston and DeReynier 1996, Livingston et al. 1986,
6 1993). These species are some of the more abundant groundfish in the EBS, and pollock constitutes a
7 large proportion of the diet for many of them. Other less abundant species that consume pollock include
8 Alaska skate, sablefish, Pacific sandfish, and various sculpins (Livingston 1989a, Livingston and
9 DeReynier 1996). Small amounts of juvenile pollock are even eaten by small-mouthed flounders such as
10 yellowfin sole and rock sole (Livingston 1991a, Livingston and DeReynier 1996, Livingston et al. 1993).
11 Age-0 and age-1 pollock are the targets of most of these groundfish predators, with the exception of
12 Pacific cod, Pacific halibut, and Alaska skate, which may consume pollock ranging in age from age-0 to
13 greater than age-6 depending on predator size.

14
15 Pollock is a significant prey item of marine mammals and birds in the EBS. Studies suggest that pollock
16 is a primary prey item of northern fur seals when feeding on the shelf during summer (Sinclair et al.
17 1997, 1994). Squid and other small pelagic fish are also eaten by northern fur seals in slope areas or in
18 other seasons. The main sizes of pollock consumed by fur seals range from 3-20 cm or age-0 and age-1
19 fish. Older age classes of pollock may appear in the diet, during years of lower abundances of young
20 pollock (Sinclair et al. 1997). Pollock has been noted as a prey item for other marine mammals including
21 northern fur seals, harbor seals, fin whales, minke whales, and humpback whales, but stomach samples
22 from these species in the EBS have been very limited, so the importance of pollock in the diets has not
23 been well-defined (Kajimura and Fowler 1984). Pollock are one of the most common prey in the diet of
24 spotted seals and ribbon seals, which feed on pollock in the winter and spring in the areas of drifting ice
25 (Lowry et al. 1997).

26
27 Essentially five species of piscivorous birds are dominant in the avifauna of the EBS: northern fulmar, red-
28 legged kittiwake, black-legged kittiwake, common murre, and thick-billed murre (Kajimura and Fowler
29 1984, Schneider and Shuntov 1993). Pollock is sometimes the dominant component in the diets of
30 northern fulmar, black-legged kittiwake, common murre and thick-billed murre, while red-legged
31 kittiwakes tend to rely more heavily on myctophids (Hunt et al. 1981, Kajimura and Fowler 1984,
32 Springer et al. 1986). Age-0 and age-1 pollock are consumed by these bird species, and the dominance of
33 a particular pollock age-class in the diet varies by year and season. Fluctuations in chick production by
34 kittiwakes have been linked to the availability of fatty fishes such as myctophids, capelin and Pacific
35 sand lance (Hunt et al. 1995). Changes in the availability of prey, including pollock, to surface-feeding
36 seabirds may be due to changes in sea surface temperatures and the locations of oceanographic features
37 such as fronts which could influence the horizontal or vertical distribution of prey (Decker et al. 1995,
38 Springer 1992).

39
40 The diet of pollock, particularly adults, in the GOA has not been studied as thoroughly as in the EBS.
41 Larvae, 5-20 mm in length, consume larval and juvenile copepods and copepod eggs (Canino 1994,
42 Kendall et al. 1987). Early juveniles (25-100 mm) of pollock in the GOA primarily eat juvenile and adult
43 copepods, larvaceans, and euphausiids while late juveniles (100-150 mm) eat mostly euphausiids,
44 chaetognaths, amphipods, and mysids (Brodeur and Wilson 1996, Grover 1990, Krieger 1985, Livingston
45 1985, Merati and Brodeur 1997, Walline 1983). Juvenile and adult pollock in southeast Alaska rely
46 heavily on euphausiids, mysids, shrimp and fish as prey (Clausen 1983). Euphausiids and mysids are
47 important to smaller pollock and shrimp and fish are more important to larger pollock in that area.
48 Copepods are not a dominant prey item of pollock in the embayments of southeast Alaska but appear

1 mostly in the summer diet. Similarly, the summer diet of pollock in the central and western GOA does
2 not contain as much copepods (Yang 1993). Euphausiids are the dominant prey, constituting a relatively
3 constant proportion of the diet by weight across pollock sizes groups. Shrimp and fish are the next two
4 important prey items.

5
6 Fish prey become an increasing fraction of the pollock diet with increasing pollock size in the GOA.
7 Over 20 different species of fish have been identified in the stomach contents of pollock from this area
8 but the dominant fish consumed is capelin (Yang 1993). A high diversity of prey fish were also found in
9 pollock stomachs. Commercially important fish prey included: Pacific cod, pollock, arrowtooth flounder,
10 flathead sole , Dover sole, and Greenland halibut. Forage fish such as capelin, eulachon and Pacific sand
11 lance, were also found in pollock stomach contents.

12
13 Dominant populations of groundfish in the GOA that prey on pollock include arrowtooth flounder,
14 sablefish, Pacific cod, and Pacific halibut (Albers and Anderson 1985, Best and St-Pierre 1986, Jewett
15 1978, Yang 1993). Pollock is one of the top five prey items (by weight) for Pacific cod, arrowtooth
16 flounder, and Pacific halibut. Other prey fish of these species include Pacific herring and capelin. Other
17 predators of pollock include great sculpins (Carlson 1995) and shortspined thornyheads (Yang 1993). As
18 found in the EBS, Pacific halibut and Pacific cod tend to consume larger pollock, and arrowtooth
19 flounder consumes pollock that are mostly less than age-3. Unlike the EBS, however, the main source of
20 predation mortality on pollock at present appears to be from the arrowtooth flounder (Livingston 1994).
21 Stock assessment authors have attempted to incorporate predation mortality by arrowtooth flounder,
22 Pacific halibut, and sea lions in the stock assessment for pollock in the GOA (Hollowed et al. 1997).

23
24 Research on the diets of marine mammals and birds in the GOA was less intensive for the Bering Sea,
25 but recently has been greatly accelerated (Brodeur and Wilson 1996, Calkins 1987, DeGange and Sanger
26 1986, Hatch and Sanger 1992, Lowry et al. 1989, Merrick and Calkins 1996, Pitcher 1980a, 1980b, 1981)
27 (Section 3.5). Brodeur and Wilson's (1996) review summarized both bird and mammal predation on
28 juvenile pollock. The main piscivorous birds that consume pollock in the GOA are black-legged
29 kittiwakes, common murre, thick-billed murre, tufted puffin, horned puffin, and probably marbled
30 murrelet. The diets of common murre have been shown to contain around 5 percent to 15 percent age-0
31 pollock by weight depending on season. The tufted puffin diet is more diverse and tends to contain more
32 pollock than that of the horned puffin (Hatch and Sanger 1992). Both horned puffins and tufted puffins
33 consume age-0 pollock. The amount of pollock in the diet of tufted puffin varied by region in the years
34 studied, with very low amounts in the north-central GOA and Kodiak Island areas, intermediate (5-20
35 percent) amounts in the Semidi and Shumagin Islands, and large amounts (25-75 percent) in the
36 Sandman Reefs and eastern Aleutian Islands. The proportion of juvenile pollock in the diet of tufted
37 puffin at the Semidi Islands varied by year and was related to pollock year-class abundance.

38
39 Pollock is a major prey of Steller sea lions and harbor seals in the GOA (Merrick and Calkins 1996,
40 Pitcher 1980a, 1980b, 1981). Harbor seals tend to have a more diverse diet, and the occurrence of pollock
41 in the diet is lower than in sea lions. Pollock is a major prey of both juvenile and adult Steller sea lions in
42 the GOA. It appears that the proportion of animals consuming pollock increased from the 1970s to the
43 1980s, and this increase was most pronounced for juvenile Steller sea lions. Sizes of pollock consumed
44 by Steller sea lions range from 5-56 cm and the size composition of pollock consumed appears to be
45 related to the size composition of the pollock population. However, juvenile Steller sea lions consume
46 smaller pollock on average than adults. Age-1 pollock was dominant in the diet of juvenile Steller sea
47 lions in 1985, possibly a reflection of the abundant 1984 year class of pollock available to Steller sea
48 lions in that year.

1 *Stock Assessment*

2
3 Currently, information on pollock in the EBS comes from the NMFS observers aboard commercial
4 fishing vessels, annual trawl surveys, and triennial echo integration (hydroacoustic; EIT) trawl surveys.
5 In the Aleutian Islands, information comes from observer data and triennial bottom trawl surveys. In the
6 GOA, stock assessment information is based on observer and port sampling data, annual hydroacoustic
7 surveys in the Shelikof Straits area, and triennial bottom trawl surveys. These different data sets are
8 analyzed simultaneously to obtain an overall view of each stock's condition. The bottom trawl data may
9 not provide an accurate view of pollock distribution because a significant portion of the pollock biomass
10 may be pelagic and not available to bottom trawls and much of the Aleutian Islands shelf is untrawlable
11 due to rough bottom.

12
13 In the EBS pollock are assessed with an age-structured model incorporating fishery data and two types of
14 survey catch data and age compositions. Bottom trawl surveys are conducted annually during June
15 through August and provide a consistent time series of adult population abundance from 1982-1997. EIT
16 surveys are run every three years (typically) and provide an abundance index on more pelagic (typically
17 younger) segments of the stock. Both surveys dispose their catches into their relative age compositions
18 prior to analyses. Fishery data include estimates of the total catch by area/time strata and also the average
19 body weight-at-age and relative age composition of the catch within each stratum. The results of the
20 statistical model applied to these data are updated annually and presented in the BSAI pollock chapter of
21 the Council's BSAI SAFE report. Also included are separate analyses on pollock stocks in the Aleutian
22 Islands and Bogoslof areas. These analyses are constrained by data limitations and are presented relative
23 to the status of the EBS stock. This analysis focused specifically on the EBS stock with the view that
24 extensions to these other areas are equally applicable. The stock assessment is reviewed by the Plan
25 Team, and by the Scientific and Statistical Committee, before being presented to the Council.

26
27 The age composition of pollock has been dominated by strong year classes—most recently there appears
28 to be higher than average 1992 year class, and prior to that the 1989 year class was very high. The
29 abundance of these year classes is evident from EIT and bottom trawl surveys in addition to the extensive
30 fishery age-composition data that have been collected. The selectivity of the fishery has cumulative
31 impacts on the age composition due to fishing mortality. The fishery has tended to exhibit variable
32 selectivity over time, but generally targets fish aged 5 years and older.

33
34 GOA pollock are also assessed with an age-structured model incorporating fishery and survey data. The
35 data used in this analysis consist of estimates of total catch biomass, bottom trawl biomass estimates, EIT
36 survey estimates of the spawning biomass in Shelikof Strait, egg production estimates of spawning
37 biomass in Shelikof Strait, and fisheries catch at age and survey size and age compositions. Fishery catch
38 statistics (including discards) are estimated by the NMFS Alaska Regional Office. These estimates are
39 based on the best blend of observer-reported catch and weekly production reports. Age composition data
40 are obtained from several sources including catch at age aggregated over all seasons, nations, vessel
41 classes and International North Pacific Fisheries Commission (INPFC) statistical areas for the years, and
42 numbers at age from the spring EIT survey and the bottom trawl surveys. An additional estimate of the
43 age composition of the population in 1973 was available from a bottom trawl survey of the GOA. Length
44 frequency data collected from the EIT survey are also included in the model, as is historical information
45 on pollock size composition obtained from the Japanese Pacific ocean perch fishery from the period
46 1964-1975 (Hollowed et al. 1991). Recent assessments have explored the impact of predation mortality
47 by arrowtooth flounder, Pacific halibut and Steller sea lions by incorporating time series of estimated
48 predator biomass, the age composition of pollock consumed by predators, and estimated consumption

1 rates (Hollowed et al. 1997).

2
3 In the GOA, ages 3 through 15 represent the recruited population, although reliable estimates of
4 abundance for ages 2 and above exist. The age composition is dominated by a recent strong 1994 year
5 class; large numbers from the strong 1988 year class are still in the population. The estimated mean age
6 of the recruited portion of the population in 1999 was 4 years.

7
8 Over the last 15 years, NOAA's Fisheries Oceanography Coordinated Investigations (FOCI) targeted
9 much of their research on understanding processes influencing recruitment of pollock in the GOA. These
10 investigations led to the development of a conceptual model of factors influencing pollock recruitment
11 (for complete review collection of papers (Kendall et al. 1996). Bailey et al. (1996) reviewed 10 years of
12 data for evidence of density dependent mortality at early life stages. Their study revealed evidence of
13 density dependent mortality only at the late larval to early juvenile stages of development. Bailey et al.
14 (1996) hypothesize that pollock recruitment levels can be established at any early life stage (egg, larval
15 or juvenile) depending on sufficient supply from prior stages. He labeled this hypothesis the supply
16 dependent multiple life stage control model. In a parallel study, Megrey et al. (1996) reviewed data from
17 FOCI studies and identified several events that are important to survival of pollock during the early life
18 history period. These events are climatic events (Hollowed and Wooster 1995, Stabeno et al. 1995),
19 preconditioning of the environment prior to spawning (Hermann et al. 1996), the ability of the physical
20 environment to retain the planktonic life stages of pollock on the continental shelf (Bograd et al. 1994,
21 Schumacher et al. 1993), and the abundance and distribution of prey and predators on the shelf (Bailey
22 and Macklin 1994, Canino 1994, Theilacker et al. 1996). Thus, the best available data suggest that
23 pollock year-class strength is controlled by sequences of biotic and abiotic events and that population
24 density is only one of several factors influencing pollock production.

25
26 In both the BSAI and GOA, cumulative impacts of fishing mortality on the age composition are
27 influenced by the selectivity of the fishery. The current age compositions of the stocks reflect a fished
28 population with a long catch history. In any given year, the age composition of the stock is influenced by
29 previous year-class strength. The reproductive potential of the stock in a given year is dependent on the
30 biomass of spawners as modified by abiotic and biotic conditions. Thus, it is likely that the average age
31 of unfished populations would have varied inter-annually due to the history of oceanic and climate
32 conditions. The NMFS's FOCI and the Coastal Ocean Program's Southeast Bering Sea Carrying
33 Capacity (SEBSCC) regional study focuses research on improving our understanding of mechanisms
34 underlying annual production of pollock stocks in the GOA and EBS. NOAA's long-term goal is to
35 improve our ability to assess quantitatively the long term impact of commercial removals of adult pollock
36 on future recruitment by combining the findings of process-oriented research programs such as FOCI and
37 SEBSCC with NMFS's on-going studies of species interactions, fish distributions, and abundance trends.

38 39 *ABC as Recommended in the Most Recent Stock Assessments*

40
41 EBS pollock fell into Tier 3a of the ABC/OFL definitions for 2000, which require reliable estimates of
42 biomass, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing fishing
43 mortality rate is the $F_{35\%}$ rate which is 0.65 for pollock and equates to a yield of 1.5 million metric tons
44 (mt) (Ianelli et al. 1999). The ABC (using $F_{ABC} = F_{40\%}$) for pollock gives a yield of 1.1 million mt. This
45 TAC was set equal to the ABC value recognizing that the $F_{40\%}$ rate was well below estimates made for
46 F_{MSY} . This lower level has been adjusted downwards to provide a risk-averse harvest rate which more
47 accurately reflects the degree of uncertainty.

1 GOA pollock fell into Tier 3 of the ABC/OFL definitions, which require reliable estimates of biomass,
2 $B_{40\%}$, $F_{30\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing rate is the fishing
3 mortality rate that reduces the spawner stock biomass to 35 percent of its unfished level (the $F_{35\%}$ rate). In
4 1999, the full recruitment fishing mortality $F_{35\%}$ rate was 0.50 for pollock and equated to a yield of
5 130,758 mt for the year 2000 central and western GOA (Dorn et al. 1999). The projected 2000 spawning
6 stock biomass fell below $B_{40\%}$, therefore the maximum allowable fishing mortality rate for ABC (F_{ABC})
7 was the adjusted $F_{40\%}$ rate 0.34 (Dorn et al. 1999). This F_{ABC} translated to a yield projection of 111,306
8 mt in 2000 for the western and central regions. The 2000 Council ABC level was 100,000 mt for the
9 western and central regions, which was equivalent to the recommended stock assessment ABC, and
10 equivalent to the TAC.

11 **Pacific Cod**

12 *Stock Description and Life History*

13
14
15
16 Pacific cod is a demersal species that occurs on the continental shelf and upper slope from Santa Monica
17 Bay, California through the GOA, Aleutian Islands, and EBS to Norton Sound (Bakkala 1984). The
18 Bering Sea represents the center of greatest abundance, although Pacific cod are also abundant in the
19 Gulf and Aleutian Islands (OCSEAP 1987). GOA, Bering Sea, and Aleutian Islands cod stocks are
20 genetically indistinguishable (Grant et al. 1987), and tagging studies show that cod migrate seasonally
21 over large areas (Shimada and Kimura 1994).

22
23 In the late winter, Pacific cod converge in large spawning masses over relatively small areas. Major
24 aggregations occur between Unalaska and Unimak Islands, southwest of the Pribilof Islands and near the
25 Shumagin group in the western Gulf (Shimada and Kimura 1994). Spawning takes place in the
26 sublittoral-bathyal zone (the area of the continental shelf and slope [40-290 m]) near the bottom. The
27 eggs sink to the bottom and are somewhat adhesive (Hirschberger and Smith 1983).

28
29 Pacific cod reach a maximum recorded age of 19. Estimates of natural mortality vary widely and range
30 from 0.29 (Thompson and Shimada 1990) to 0.83-0.99 (Ketchen 1964). For stock assessment purposes, a
31 value of 0.37 is used in both the BSAI (Thompson et al. 1999) and the GOA (Thompson and Dorn 1999).
32 In the BSAI, 50 percent of Pacific cod are estimated to reach maturity by the time they reach 67 cm in
33 length, or about 5 years of age (Thompson et al. 1999).

34 *Trophic Interactions*

35
36
37 Pacific cod are omnivorous. Livingston (1991b) characterized the diet of Pacific cod in the BSAI and
38 GOA as follows: In terms of percent occurrence, the most important items were polychaetes, amphipods,
39 and crangonid shrimp; in terms of numbers of individual organisms consumed, the most important items
40 were euphausiids, miscellaneous fishes, and amphipods; and in terms of weight of organisms consumed,
41 the most important items were pollock, fishery offal, and yellowfin sole. Small Pacific cod were found to
42 feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod
43 include halibut, salmon shark, northern fur seals, Steller sea lions, harbor porpoises, various whale
44 species, and tufted puffin (Westheim 1996).

45 *Fishery*

46
47
48 The Pacific cod fishery is the second largest Alaskan groundfish fishery. In 1999, Pacific cod constituted

1 12 percent of the groundfish catch in the BSAI and 30 percent of the groundfish catch in the GOA. The
2 fishery for Pacific cod is conducted with bottom trawl, longline, pot, and jig gear. Of these, the fishery
3 conducted with jig gear is by far the smallest. More than 100 vessels participate in each of the three
4 larger fisheries. The age at 50 percent recruitment varies between regions. For trawl, longline, and pot
5 gear, the age at 50 percent recruitment in the EBS is approximately 4, 4, and 5 years, respectively
6 (Thompson and Dorn 1999). For all three gears, the age at 50 percent recruitment in the GOA is
7 approximately 6 years (Thompson et al. 1999). The trawl fishery is typically concentrated during the first
8 few months of the year, whereas fixed-gear fisheries may sometimes run essentially year-round. Bycatch
9 of crab and halibut often causes the Pacific cod fisheries to close prior to reaching the TAC. In the EBS,
10 trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is
11 distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl
12 fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the
13 longline fishery is located primarily in the vicinity of the Shumagins. Pacific cod is also taken as bycatch
14 in a number of trawl fisheries. In the EBS, Pacific cod is taken as bycatch in the trawl fisheries for
15 pollock, yellowfin sole, and rock sole. In the Aleutian Islands region, Pacific cod is taken as bycatch in
16 the trawl fishery for Atka mackerel. In the GOA, Pacific cod is taken as bycatch in the trawl fisheries for
17 shallow-water flatfish, arrowtooth flounder, and flathead sole. Since 1998, discarding of Pacific cod has
18 been prohibited except in fisheries where Pacific cod is in “bycatch only” status.

19 *Stock Assessment*

21
22 Beginning with the 1993 BSAI SAFE report (Thompson and Methot 1993) and the 1994 GOA SAFE
23 report (Thompson and Zenger 1994), Pacific cod have been assessed with a length-based synthesis model
24 (Methot 1990). Although the Pacific cod stocks in the EBS and GOA are modeled separately, the model
25 structures in recent years have been identical (Thompson and Dorn 1999, Thompson et al. 1999). No
26 formal assessment model exists for the Aleutian Islands portion of the BSAI stock. Instead, results from
27 the EBS assessment are inflated proportionally to account for Aleutian Islands fish.

28
29 Annual trawl surveys in the EBS and triennial trawl surveys in the Aleutian Islands and GOA are the
30 primary fishery-independent sources of data for Pacific cod stock assessments (Thompson and Dorn
31 1999, Thompson et al. 1999). For the most recent assessments, fishery size compositions were available,
32 by gear, for the years 1978 through the first part of 1997. The catch history was divided into two
33 portions, determined by the relative importance of the domestic fishery. A “pre-domestic” portion was
34 defined as those years in which the domestic fishery took less than half the catch, and a “domestic”
35 portion was defined as those years in which the domestic fishery took at least half the catch. Within each
36 year (in both portions of the time series), catches were divided according to three time periods: January-
37 May, June-August, and September-December. This particular division, which was suggested by
38 participants in the EBS fishery, is intended to reflect actual intra-annual differences in fleet operation
39 (e.g., fishing operations during the spawning period may be different than at other times of year). Four
40 fishery size composition components were included in the likelihood functions used to estimate model
41 parameters: the period 1 trawl fishery, the periods 2-3 trawl fishery, the longline fishery, and the pot
42 fishery. In addition to the fishery size composition components, likelihood components for the size
43 composition and biomass trend from the bottom trawl surveys were included in the model. All
44 components were weighted equally.

45
46 Quantities estimated in the most recent stock assessments include parameters governing the selectivity
47 schedules for each fishery and survey in each portion of the time series, parameters governing the length-
48 at-age relationship, population numbers at age for the initial year in the time series, and recruitments in

1 each year of the time series. Given these quantities, plus parameters governing natural mortality, survey
2 catchability, the maturity schedule, the weight-at-length relationship, and the amount of spread
3 surrounding the length-at-age relationship, the stock assessments reconstruct the time series of numbers
4 at age and the population biomass trends (measured in terms of both total and spawning biomass). The
5 model around which the most recent Pacific cod assessments are structured uses an assumed survey
6 catchability of 1.0 and an assumed natural mortality rate of 0.37. Other outputs of the assessments
7 include projections of biomass and harvest under a variety of reference fishing mortality rates. Based on
8 these projections, the scientists responsible for conducting the assessments recommend a pair of ABC
9 values for the coming year (one value for the BSAI and one for the GOA).

10
11 Pacific cod is currently managed under Tier 3 of the Council's ABC and OFL definitions (Amendment 56
12 to each of the respective FMPs). Management under Tier 3 requires reliable estimates of projected
13 biomass, $B_{40\%}$, $F_{40\%}$ (for ABC), and $F_{35\%}$ (for OFL).

14 *ABC as Recommended in the Most Recent Stock Assessments*

15
16 Under Tier 3 of Amendment 56 to the BSAI and GOA Groundfish FMPs, the maximum permissible
17 ABC depends on the relationship of projected spawning biomass to $B_{40\%}$. For the BSAI, the base model in
18 the 1999 assessment projected a 2000 spawning biomass of 355,000 mt, about 6 percent below the $B_{40\%}$
19 estimate of 379,000 mt, leading to a maximum permissible ABC of 206,000 mt (Thompson and Dorn
20 1999). For the GOA, the base model in the 1999 assessment projected a 2000 spawning biomass of
21 111,000 mt, about 12 percent above the $B_{40\%}$ estimate of 98,800 mt, leading to a maximum permissible
22 ABC of 86,000 mt (Thompson et al. 1999). To determine whether ABC should be set at the maximum
23 permissible level, the 1999 assessments presented a decision-theoretic analysis of the statistical
24 uncertainty surrounding the respective model's projected $F_{40\%}$ catch level, specifically the uncertainty
25 associated with the assumed values of the natural mortality rate ($M=0.37$) and survey catchability
26 coefficient ($q=1.0$). These analyses resulted in a recommended 2000 ABC of 193,000 mt for the BSAI
27 region and 76,400 mt for the GOA region.
28
29

30 **Flathead Sole**

31
32 Flathead sole is distributed from northern California northward throughout Alaska (Wolotira et al. 1993).
33 In the northern part of its range, it overlaps with the related and very similar Bering flounder (Hart 1973).
34 Because it is difficult to separate these two species at sea, they are currently managed as a single stock
35 (Walters and Wilderbuer 1997). Adults are benthic and occupy separate winter spawning and summer
36 feeding distributions. From over-wintering grounds near the continental shelf margin, adults begin a
37 migration onto the mid and outer continental shelf in April or May. The spawning period occurs in the
38 spring, primarily in deeper waters near the margins of the continental shelf (Walters and Wilderbuer
39 1997). Eggs are large and pelagic. Upon hatching, the larvae are planktonic and usually inhabit shallow
40 areas (Waldron and Vinter 1978). Exact age and size at maturity are unknown, but recruitment to the
41 fishery begins at age 3. The maximum age for flathead sole is approximately 20 years. An estimated
42 natural mortality rate of 0.20 is used for stock assessment (Turnock et al. 1997a, Waldron and Vinter
43 1978). Flathead sole feed primarily on invertebrates such as amphipods and decapods. In the EBS, other
44 fish species represented 5-25 percent of the diet (Livingston et al. 1993). Flathead sole are taken in
45 bottom trawls both as a directed fishery and in pursuit of other bottom dwelling species.
46

47 The following information is available to assess the unit stock condition:
48

Data Component	Years of Data
Fishery catch	1977 to 1999
Foreign fishery size composition data	1977 to 1989
Domestic fishery size composition data	1990 to 1998
NMFS trawl survey biomass estimates	1982 to 1999
NMFS trawl survey size composition data	1982 to 1999
NMFS trawl survey age composition data	1982, 1985, 1992, 1995

Annual trawl survey biomass results have been the primary data component used to assess stock level since 1982, although all the above information was also input into a length-based stock assessment model (Spencer et al. 1999a). The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report.

Flathead sole are currently managed under Tier 3 of the Council’s ABC and OFL definitions (Amendment 44 to the FMP). Management under Tier 3 requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC) and $F_{35\%}$ (for OFL). Since the projected flathead sole female spawning biomass for 2000 is greater than $B_{40\%}$ (261,300 > 133,800), $F_{40\%}$ (the upper limit on ABC), is recommended as the F_{ABC} harvest reference point for 2000. The 2000 TAC is well below the ABC and the 1999 catch was only 23 percent of the 1999 TAC, as follows: BSAI 2000 ABC = 73,500 mt, BSAI TAC = 52,652 mt, and BSAI 1999 catch = 17,777 mt.

Rock Sole

Rock sole are distributed from southern California northward through Alaska (Wolotira et al. 1993). Two species of rock sole occur in the North Pacific ocean, a northern rock sole and a southern rock sole. These species have an overlapping distribution in the GOA, but the northern species primarily comprise the BSAI populations, where they are managed as a single stock (Wilderbuer and Walters 1997). Adults are benthic and, in the EBS, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Spawning takes place during the late winter-early spring, near the edge of the continental shelf at depths of 125 to 250 m. Eggs are demersal and adhesive (Forrester 1964). The estimated age at 50 percent maturity for female rock sole is 9-10 years at a length of 35 cm (Wilderbuer and Walters 1997). The best estimate for natural mortality is 0.18 for the BSAI (Wilderbuer and Walters 1992) and 0.20 for the GOA (Turnock et al. 1997a). Rock sole are important as the target of a high value bottom trawl roe fishery occurring in February and March, which accounts for the majority of the BSAI catch. Although female rock sole are highly desirable when in spawning condition, large amounts are discarded in other trawl fisheries during the rest of the year. Commercial harvest occurs primarily on the EBS continental shelf and in lesser amounts in the Aleutian Islands region.

Northern and southern rock sole are managed as a single unit in the BSAI. Rock sole are abundant on the EBS shelf and to a lesser extent in the Aleutian Islands. This species represents a “data-rich” case where the following information is available.

Data Component	Years of Data
Trawl fishery catch at age	1980 to 1998
Trawl survey population age composition	1975, 1979 to 1998
Catch weight	1975 to 1999
Trawl survey biomass estimates and standard error.	1982 to 1999
Maturity schedule	1993 to 1994
Mean weight at age	1985 to 1988

The time-series of fishery and survey age compositions allows the use of an age-based stock assessment model as the primary analytical tool (Wilderbuer and Walters 1999). The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report.

Rock sole are currently managed under Tier 3 of the Council’s ABC and OFL definitions (Amendment 44 to the FMP). Management under Tier 3 requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC) and $F_{35\%}$ (for OFL). Since the projected rock sole female spawning biomass for 2000 is greater than $B_{40\%}$ (675,500 > 284,700), $F_{40\%}$ (the upper limit on ABC), is recommended as the F_{ABC} harvest reference point for 2000. ABC and TAC information are as follows: BSAI 2000 ABC = 230,000 mt, BSAI TAC = 134,760 mt, and BSAI 1999 catch = 40,362 mt.

Greenland Turbot

Greenland turbot are distributed from Baja California northward throughout Alaska, although it is rare south of Alaska and is primarily distributed in the eastern BSAI region (Hubbs and Wilimovsky 1964). Juveniles are believed to spend the first three or four years of life on the continental shelf and then move to the continental slope as adults (Alton et al. 1988, Templeman 1973). Greenland turbot are demersal to semi-pelagic. Unlike most flatfish, the migrating eye of Greenland turbot does not move completely to one side, but stops at the top of the head, which presumably results in a greater field of vision and helps to explain this species’ tendency to feed off the sea bottom (de Groot 1970). Spawning occurs in winter and may be protracted, starting as early as September and continuing until March (Bulatov 1983). The eggs are benthypelagic (suspended in the water column near the bottom)(D'yakov 1982). Juveniles are absent in the Aleutian Islands region, suggesting that populations in that area originate from elsewhere (Alton et al. 1988). Greenland turbot are a moderately long-lived species, with a maximum recorded age of 21 years (Ianelli and Wilderbuer 1995) and an estimated natural mortality rate of 0.18 (Ianelli et al. 1997). Pelagic fish are the main prey of Greenland turbot, with pollock often a major species in the diet (Livingston 1991b). Greenland turbot also feed on squid, euphausiids and shrimp.

Abundance of juvenile Greenland turbot is estimated in the EBS by the annual trawl survey and in the Aleutian Islands by the triennial trawl survey. Abundance of adults has been estimated by trawl slope surveys conducted cooperatively by the U.S. and Japan. In the Gulf, abundance is estimated by the triennial trawl survey. A lack of deepwater samples, however, creates a high degree of uncertainty for

1 these estimates (Turnock et al. 1997a). The biomass of Greenland turbot in the BSAI increased during
 2 the 1970s and is currently estimated to be about half of the unfished level. A lack of recruitment success
 3 during recent years has led to extra caution in setting harvest levels. Greenland turbot is a relatively
 4 valuable species; however, because of low ABC and TAC amounts, it is primarily a bycatch only fishery.
 5 They are caught both in bottom trawls and on longlines.

6
 7 The resource in the BSAI is managed as a single stock. The following information is available to assess
 8 the stock condition of Greenland turbot in the BSAI.

Data Component	Years of Data
Trawl survey size-at-age	1975, 1979 to 1982
Shelf survey size composition and biomass	1979 to 1999
Slope survey size composition and biomass	1979, 1981, 1982, 1985, 1988, 1991
Longline survey size composition and abundance index	1983 to 1993
Total fishery catch data	1960 to 1999
Trawl fishery CPUE index	1978 to 1984
Trawl fishery size compositions	1977 to 1987, 1989 to 1991, 1993 to 1998
Longline catch size composition	1977, 1979 to 1985, 1992 to 1998

19
 20
 21 The time-series of fishery and survey length compositions allows the use of a length-based stock
 22 assessment model (Ianelli et al. 1997). The outputs include estimates of abundance, spawning biomass,
 23 fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also
 24 estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished
 25 levels which, when considered with projected future biomass, are used to calculate ABC. The stock
 26 assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the
 27 BSAI SAFE report.

28
 29 Greenland turbot are currently managed under Tier 3 of the Council's ABC and OFL definitions
 30 (Amendment 44 to the FMP). Management under Tier 3 requires reliable estimates of projected biomass,
 31 $B_{40\%}$, $F_{40\%}$ (for ABC) and $F_{35\%}$ (for OFL). Since the projected Greenland turbot female spawning biomass
 32 for 2000 is greater than $B_{40\%}$ (165,000 > 81,300), $F_{40\%}$ is considered the upper limit on ABC. However,
 33 the recommended F_{ABC} for 2000 is 25 percent of $F_{40\%}$ due to the lack of recruitment for the past 25 years
 34 and the anticipated declining future stock condition. ABC and TAC information are as follows: BSAI
 35 2000 ABC = 9,300 mt, BSAI TAC = 9,300 mt, and BSAI 1999 catch = 5,776 mt.

36 37 **Yellowfin Sole**

38
 39 Yellowfin sole is distributed from British Columbia to the Chukchi Sea (Hart 1973). In the Bering Sea, it
 40 is the most abundant flatfish species and is the target of the largest flatfish fishery in the United States.
 41 While also found in the Aleutian Islands and GOA, the stock is of much smaller size in those areas.
 42 Adults are benthic and occupy separate winter and spring/summer spawning/feeding grounds. Adults
 43 overwinter near the shelf-slope break at approximately 200 m and move into nearshore spawning areas as

1 the shelf ice recedes (Nichol 1997). Spawning is protracted and variable, beginning as early as May and
 2 continuing through August, occurring primarily in shallow water at depths less than 30 m (Wilderbuer et
 3 al. 1992). Eggs, larvae and juveniles are pelagic and usually are found in shallow areas (Nichol 1994).
 4 The estimated age at 50 percent maturity is 10.5 years at a length of approximately 29 cm (Nichol 1994).
 5 The natural mortality rate likely falls within the range of 0.12 to 0.16, with a maximum recorded age of
 6 33 years (Wilderbuer 1997). Yellowfin sole feed primarily on benthic invertebrates, with polychaetes,
 7 amphipods, decapods and clams dominating the diet in the EBS (Livingston 1993).

8
 9 Yellowfin sole stocks were over-exploited by foreign fisheries in 1959-1962. Since that time, indices of
 10 relative abundance have shown major increases in abundance during the late 1970s. Since 1981,
 11 abundance has fluctuated widely but biomass estimates indicate that the yellowfin sole population
 12 remains at a high, stable level. Information on yellowfin sole stock conditions in the BSAI comes
 13 primarily from the annual EBS trawl survey. Estimates of yellowfin sole biomass derived from these
 14 surveys have been more variable than would be expected for a comparatively long-lived and lightly
 15 exploited species (Wilderbuer 1997). The reason for this variability is not known. However, Nichol
 16 (1997) hypothesized that much of the yellowfin sole resource is found at depths less than 30 m during the
 17 summer when bottom trawl surveys are conducted. This could cause the survey to underestimate the
 18 abundance of yellowfin sole.

19
 20 In the Bering Sea, yellowfin sole are considered as one stock for management purposes. The following
 21 information is available for stock assessment.

Data Component	Years of Data
Trawl Fishery catch-at-age	1964 to 1998
Trawl survey population age composition	1975, 1979 to 1998
Catch weight	1982 to 1999
Trawl survey biomass estimates and S.E..	1954 to 1999
Maturity schedule	1992 to 1993
Mean weight at age	1979 to 1990

30
 31 The time-series of fishery and survey age compositions allows the use of an age-based stock assessment
 32 model (Wilderbuer 1997). The outputs include estimates of abundance, spawning biomass, fishery and
 33 survey selectivity, exploitation trends, and projections of future biomass. The model also estimates
 34 reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels
 35 which, when considered with projected future biomass, are used to calculate ABC. The stock assessment
 36 is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI
 37 SAFE report.

38
 39 Yellowfin sole are currently managed under Tier 3 of the Council's ABC and OFL definitions (Appendix
 40 1; Amendment 44). Management under Tier 3 requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$
 41 (for ABC) and $F_{35\%}$ (for OFL). Since the projected yellowfin sole female spawning biomass for 2000 is
 42 greater than $B_{40\%}$ (789,300 > 576,600), $F_{40\%}$ (the upper limit on ABC), was recommended as the F_{ABC}
 43 harvest reference point for 2000. ABC and TAC information are as follows: BSAI 2000 ABC = 191,000
 44 mt, BSAI TAC = 123,262 mt, and BSAI 1999 catch = 67,392 mt.

1 **Arrowtooth Flounder**

2
3 Arrowtooth flounder is common from Oregon through the EBS (Allen and Smith 1988). The very similar
4 Kamchatka flounder also occurs in the Bering Sea. Because it is not usually distinguished from
5 arrowtooth flounder in commercial catches, both species are managed as a group. Arrowtooth flounder is
6 a relatively large flatfish that occupies continental shelf waters almost exclusively until age 4, but at
7 older ages occupies both shelf and slope waters, with concentrations at depths between 100 and 200 m
8 (Martin and Clausen 1995). Spawning is protracted and variable and probably occurs from September
9 through March (Zimmermann 1997). For female arrowtooth flounder collected off the Washington coast,
10 the estimated age at 50 percent maturity was 5 years with an average length of 37 cm. Males matured at 4
11 years and 28 cm (Rickey 1995). Values of 50 percent maturity for the Bering Sea stock are 42.2 cm and
12 46.9 cm for males and females, respectively (Zimmerman 1997). The maximum reported ages are 16
13 years in the Bering Sea, 18 years in the Aleutian Islands and 23 years in the GOA, with a natural
14 mortality rate used for assessment purposes of 0.2 (Turnock et al. 1997b, Wilderbuer and Sample 1997).
15 Arrowtooth flounder are important as a large and abundant predator of other groundfish species. Adults
16 are almost exclusively piscivorous and over half their diet can consist of pollock (Livingston 1991b).
17 Currently, arrowtooth flounder have a low perceived commercial value because the flesh softens soon
18 after capture due to protease enzyme activity (Greene and Babbitt 1990). Enzyme inhibitors such as beef
19 plasma have been found to counteract this flesh-softening activity, but suitable markets have not been
20 established to support increased harvests. Thus, they are primarily caught by bottom trawls as bycatch in
21 other high value fisheries. Stocks are lightly exploited and appear to be increasing in both the GOA and
22 the BSAI. Information on arrowtooth flounder stock conditions in the BSAI comes primarily from the
23 annual EBS shelf trawl survey. Limited information is also available from past slope surveys (1981-91)
24 and catch sampling of the commercial fishery.
25

26 Information on Bering Sea arrowtooth flounder is available from the following sources:
27

Data Component	Years of Data
Fishery catch	1970 to 1999
Shelf survey biomass and Southeast	1982 to 1999
Slope survey biomass and Southeast	1981, 1982, 1985, 1988, 1991
Shelf survey size composition (by sex)	1979 to 1999
Slope survey size composition (by sex)	1981, 1982, 1985, 1988, 1991
Fishery length-frequencies from observers	1978 to 1991

35
36 The time-series of fishery and survey size compositions allows the use of an size-based stock assessment
37 model (Wilderbuer and Sample 1997). The outputs include estimates of sex-specific abundance,
38 spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass.
39 The model also estimates reference fishing mortality rates in terms of the ratio of female spawning
40 biomass to unfished levels which, when considered with projected future biomass, are used to calculate
41 ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is
42 incorporated into the BSAI SAFE report.
43

44 The reference fishing mortality rate and ABC for arrowtooth flounder are determined by the amount of

1 population information available (Appendix 1; Amendment 44). Arrowtooth flounder are managed under
 2 Tier 3 of the ABC/OFL definition since equilibrium recruitment could be approximated by the average
 3 recruitment from the time-series estimated in the stock assessment, and $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ could be
 4 estimated. In the 1999 assessment, projected biomass in 2000 is greater than $B_{40\%}$ (496,000t >194,600 t)
 5 so the $F_{40\%}$ fishing mortality rate (the upper limit) was recommended for calculating ABC. The 2000
 6 Council TAC was set equal to the ABC. Increased future harvest is likely constrained by Pacific halibut
 7 bycatch limitations. ABC and TAC information are as follows: BSAI 2000 ABC = 131,000 mt, BSAI
 8 TAC = 131,000 mt, and BSAI 1999 catch = 10,679.

9
 10 Information on GOA arrowtooth flounder used for stock assessments is available from the following
 11 sources:

Data Component	Years of Data
Fishery catch	1960 to 1999
IPHC trawl survey biomass and S.E.	1961 to 1962
NMFS exploratory research trawl survey biomass and S.E.	1973 to 1976
NMFS triennial trawl survey biomass and S.E.	1984, 1987, 1990, 1993, 1996, 1999
Fishery size compositions	1977 to 1981, 1984 to 1993, 1995 to 1996
NMFS triennial trawl survey size compositions	1984, 1987, 1990, 1993, 1996, 1999
NMFS GOA groundfish surveys length-at-age data	1975, 1977 to 1978, 1980 to 1983
NMFS triennial trawl survey length-at-age data	1984, 1987, 1990, 1993, 1996

22
 23 Current abundance estimates indicate that arrowtooth flounder have the largest biomass of the groundfish
 24 species inhabiting the GOA. The time-series of fishery and survey size compositions allows the use of a
 25 size-based stock assessment model (Turnock et al. 1997b). The outputs include estimates of sex-specific
 26 abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of
 27 future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female
 28 spawning biomass to unfished levels which are used to calculate ABC. The stock assessment is updated
 29 annually and incorporated into the GOA SAFE report.

30
 31 The reference fishing mortality rate and ABC for arrowtooth flounder are determined by the amount of
 32 population information available. Assuming that equilibrium recruitment can be approximated by the
 33 average recruitment from the time-series estimated in the stock assessment, $B_{40\%}$, $F_{40\%}$, and $F_{30\%}$ are
 34 known and because biomass in 2000 is greater than $B_{40\%}$ (1,075,900 > 436,700), $F_{40\%}$ (the upper limit) is
 35 the recommended fishing mortality rate to calculate ABC. The 2000 Council TAC of 35,000 mt is well
 36 below the ABC of 145,360 mt recommended from the stock assessment. Increased future harvest is likely
 37 constrained by Pacific halibut bycatch limitations. ABC and TAC information are as follows: BSAI
 38 2000 ABC = 145,360 mt, BSAI TAC = 35,000 mt, and BSAI 1999 catch = 16,062 mt.

39 Other Flatfish

40
 41 In the Bering Sea, eight other flatfish species are managed under the FMPs. Alaska plaice, rex sole,
 42

1 Dover sole, starry flounder, English sole, butter sole, sand sole, and deep sea sole. Adults of all species
 2 are benthic and occupy separate winter spawning and summer feeding grounds. Adults overwinter in
 3 deeper water and move into nearshore spawning areas in the late winter and spring. Spawning takes place
 4 as early as November for Dover sole (Hagerman 1952) but occurs from February through April for most
 5 species (Hart 1973). All flatfish eggs are pelagic and sink to the bottom shortly before hatching
 6 (Alderdice and Forrester 1968, Hagerman 1952, Orcutt 1950, Zhang 1987), except for butter sole, which
 7 has demersal eggs (Levings 1968).

8
 9 In the Bering Sea, Alaska plaice is the most abundant and commercially important of the other flatfish
 10 species. It is a comparatively long-lived species, and has frequently been aged as high as 25 years. For
 11 stock assessment purposes, a natural mortality rate of 0.25 is used (Wilderbuer and Walters 1997).
 12 Alaska plaice appear to feed primarily on polychaetes, marine worms and other benthic invertebrates
 13 (Livingston and DeReynier 1996, Livingston et al. 1993). For the other seven species in the BSAI “other
 14 flatfish” management category, little is known of their feeding habits, spawning, growth characteristics or
 15 seasonal movements and population age/size structure.

16
 17 In general, other flatfish are taken as bycatch in bottom trawl fisheries for other groundfish. Alaska plaice
 18 are also taken in directed bottom trawl fisheries in the EBS. Because other flatfish are generally not
 19 targeted, commercial catch data is of limited use for stock assessment purposes. The principal source of
 20 information for evaluating the condition of other flatfish stocks in the BSAI is the annual EBS shelf trawl
 21 survey.

22
 23 A moderate amount of information is available for Alaska plaice in the Bering Sea and is summarized
 24 below.

Data Component	Years of Data
Catch number at age	1971 to 1979, 1988, 1995
Total catch weight	1971 to 1999
Age-specific estimates of proportion of mature females	1971 to 1996
Trawl survey biomass estimates and S.E.	1982 to 1999
Survey age composition	1979, 1981, 1982, 1988, 1992 to 1995

25
 26
 27
 28
 29
 30
 31
 32
 33 The time series of fishery and survey age compositions allows the use of an age-based stock assessment
 34 model (Spencer et al. 1999b). The outputs include estimates of abundance, spawning biomass, fishery
 35 and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates
 36 reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels
 37 which, when considered with projected future stock abundance, are used to calculate ABC. For the rest
 38 of the species of the “other flatfish” management group, annual trawl survey biomass estimates are
 39 considered the best information available to determine the stock biomass. The stock assessment is
 40 updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE
 41 report. ABC and TAC information are as follows: BSAI 2000 ABC = 117,000 mt, BSAI TAC = 83,813
 42 mt, and BSAI 1999 catch = 15,184 mt.

43
 44 The other flatfish species complex in the GOA is currently managed as four categories with separate

1 ABCs: shallow-water flatfish, deep-water flatfish, flathead sole and rex sole. The shallow-water flatfish
 2 consists of Alaska plaice, starry flounder, yellowfin sole, English sole, butter sole, northern rock sole,
 3 and southern rock sole. Deep-water flatfish are: Dover sole, Greenland turbot, and deepsea sole. The
 4 shallow water category catch in 1999 was about 60 percent rock sole (southern and northern combined),
 5 15 percent butter sole, 11 percent starry flounder, 4 percent English sole, 4 percent yellowfin sole, <1
 6 percent Alaska plaice and 5 percent sand sole. The deep water catch is practically all Dover sole (over 99
 7 percent in 1999).

8
 9 The classification into the shallow-water and deep-water groups was due to significant differences in
 10 halibut bycatch rates in directed fisheries targeting on shallow and deep water flatfish species. Flathead
 11 sole were assigned a separate ABC due to their overlap in depth distribution of the shallow and deep
 12 water groups. In 1993, rex sole was split out of the deep-water management category because of concerns
 13 regarding the Pacific ocean perch bycatch in the rex sole target fishery. The information available for
 14 each species varies.

Data Component	Years of Data
Age composition from surveys-not all species	Various years
Triennial bottom trawl survey biomass and S.E.	1984, 1987, 1990, 1993, 1996, 1999
Total fishery catch weight by management category	Various years
Survey size composition	1984, 1987, 1990, 1993, 1996, 1999

21 Stock assessment models were not used for any of the species here due to the lack of available
 22 information (Turnock et al. 1999). Triennial trawl survey biomass estimates from 1984, 1987, 1990,
 23 1993, 1996 and 1999 are considered the best information available to determine the stock biomass for all
 24 of the “other flatfish” species.

25
 26
 27 The reference fishing mortality rate and ABC for the flatfish management groups are determined by the
 28 amount of population information available. Rock sole, for which maturity information from Bering sea
 29 rock sole is deemed adequate, are in Tier 4 of the ABC and overfishing definitions, where $F_{ABC} = F_{40\%}$
 30 and $F_{OFL} = F_{30\%}$. ABCs for all flatfish except rock sole, deep-sea sole and Greenland turbot were
 31 calculated using $F_{ABC} = 0.75 M$ and $F_{OFL} = M$ (Tier 5), because maturity information was not available.
 32 Natural mortality was assumed to be 0.2 for all flatfish species except Dover sole where natural mortality
 33 is 0.1. Greenland turbot and Deep-sea sole are in Tier 6 because no reliable biomass estimates exist,
 34 where $ABC = 0.75 OFL$ and the overfishing level (OFL) = the average catch from 1978 to 1995.

35
 36 The TAC is well below the ABC for shallow-water group and flathead sole. The ABC, TAC, and catch
 37 are summarized below. The TAC is essentially the same as the ABC for the deep-water group and rex
 38 sole. The flatfish fishery in the GOA mainly targets rock sole, rex sole, and Dover sole. The catch of
 39 flatfish is limited by the bycatch of halibut and does not reach the TAC for any species group.

GOA	GOA 2000	GOA 2000	GOA 1999
Management Group	ABC	TAC	Catch
Shallow-water	37,860	19,400	2,545
Deep-water	5,300	5,300	2,285

1	Flathead sole	26,270	9,060	891
2	Rex sole	9,440	9,440	3,057

3
4 **Sablefish**

5
6 Sablefish is found from northern Mexico to the GOA, westward to the Aleutian Islands, and in gullies
7 and deep fjords, generally at depths greater than 200 m. Sablefish observed from a manned submersible
8 were found on or within 1 m of the bottom (Krieger 1997). Several studies have shown sablefish to be
9 highly migratory for at least part of their life cycle (Heifetz and Fujioka 1991, Maloney and Heifetz
10 1997), and substantial movement between the BSAI and the GOA has been documented (Heifetz and
11 Fujioka 1991). Thus sablefish in Alaskan waters are assessed as a single stock (Sigler et al. 1999). Adults
12 reach maturity at 4 to 5 years and a length of 51 to 54 cm (McFarlane and Beamish 1990). Spawning is
13 pelagic at depths of 300-500 m near the edges of the continental slope (McFarlane and Nagata 1988).
14 Juveniles are pelagic and appear to move into comparatively shallow near-shore areas where they spend
15 the first 1 to 2 years (Rutecki and Varosi 1997). Sablefish are long-lived, with a maximum recorded age
16 in Alaska of 62 years (Sigler et al. 1997). For stock assessments, a natural mortality rate of about 0.1 has
17 been estimated (Sigler et al. 1999). It appears that sablefish are opportunistic feeders. Feeding studies
18 conducted in Oregon and California, found that fish made up 76 percent of the diet (Laidig et al. 1997).
19 Other studies, however, have found a diet dominated by euphausiids (Tanasichuk 1997).
20

21 Alaskan sablefish are considered a single stock and assessed in a combined area (BSAI and GOA) with
22 an age-structured model incorporating fishery and survey catch data and age and length compositions.
23 Survey data come from annual sablefish longline surveys in the GOA, and biennial longline surveys in
24 the BSAI. These surveys indicate that the stock size peaked in the mid-1980s because of a series of
25 strong year classes and has declined to lower level since.
26

27 The stock assessment includes catch history, fishery description, assessment methods, abundance and
28 exploitation trends, and projected catch and abundance. Sablefish fall into Tier 3 of the ABC/OFL
29 definitions, which requires reliable estimates of biomass, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$. Under the definitions and
30 projected stock conditions in 1999, the overfishing fishing mortality rate was the adjusted $F_{35\%}$ rate which
31 was 0.136 for sablefish and equated to a combined stock yield of 21,400 mt. Projections for 2000 showed
32 that the maximum allowable fishing mortality rate for ABC (F_{ABC}) was the adjusted $F_{40\%}$ rate (0.109) and
33 translated to a combined stock yield of 17,300 mt. The 2000 ABC recommendation was set at the
34 adjusted $F_{40\%}$ rate. The stock assessment authors also constructed an approximate probability figure on
35 the odds of the year 2004 spawning biomass dropping below the projected year 2000 level. They
36 determined that a constant 5-year catch scenario of 17,000 mt was appropriate for minimizing the risks of
37 further stock declines.
38

39 Relatively strong yearclasses include the 1990 and 1995 cohorts, and the 1997 appears to be relatively
40 strong although this assessment is based on only a single year of data. Abundance has fallen in recent
41 years because recent recruitment is insufficient to replace strong year classes from the later 1970s which
42 are dying off. The estimated mean age of the recruited portion of the population is 7.3 years. The
43 dominating factor determining the age composition is the magnitude of the recruiting year classes. The
44 selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the
45 current composition is also the result of a fished population with a several-decade catch history. How the
46 current age composition of the population compares with the unfished population is unknown.
47

1 The directed fishery for sablefish is prosecuted by longlining. Sablefish are caught incidentally in trawl
2 fisheries. A tiny amount of sablefish is caught by pot boats. By gear, the catches in 1998 were longlines
3 (90 percent), trawls (10 percent) and pots (<1 percent). The directed fishery occurs on the upper
4 continental slope and a few deepwater gullies, the areas inhabited by adult sablefish. The average discard
5 from 1994 to 1997 was 3 percent for all longline fisheries and 27 percent for all trawl fisheries.
6

7 Larval sablefish feed on a variety of small zooplankton ranging from copepod nauplii to small
8 amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e.,
9 euphausiids). The older demersal juveniles and adults appear to be opportunistic feeders, with food
10 ranging from variety of benthic invertebrates, benthic fishes, as well as squid, mesopelagic fishes,
11 jellyfish, and fishery discards. Gadid fish (mainly pollock) comprise a large part of the sablefish diet.
12 Nearshore residence during their second year provides the opportunity to feed on salmon fry and smolts
13 during the summer months. Young-of-the-year sablefish are commonly found in the stomachs of salmon
14 taken in the southeast troll fishery during the late summer.
15

16 **Rockfish**

17
18 At least 32 rockfish species of the genus *Sebastes* and *Sebastolobus* have been reported to occur in the
19 GOA and BSAI (Eschmeyer et al. 1984), and several are of commercial importance. Pacific ocean perch
20 has historically been the most abundant rockfish species in the region and has contributed most to the
21 commercial rockfish catch. Other species such as northern rockfish, rougheye rockfish, shortraker
22 rockfish, shortspine thornyheads, yelloweye rockfish, and dusky rockfish are also important to the overall
23 rockfish catch. The TAC levels for these and all other rockfish species are determined on an annual basis
24 by the Council. Among the main inputs needed for making this determination are the ABC and OFL
25 recommendations from annual stock assessments conducted for each species and/or species assemblage.
26

27 Rockfish in the GOA is currently managed as four assemblages: 1) slope rockfish, 2) pelagic shelf
28 rockfish, 3) demersal shelf rockfish, and 4) thornyheads. Separate ABCs, OFLs, and TACs are set for
29 each assemblage except for slope rockfish which is further subdivided into four subgroups with separate
30 ABCs, OFLs, and TACs: 1) Pacific ocean perch, 2) shortraker and rougheye rockfish, 3) northern
31 rockfish, and 4) "other slope rockfish".
32

33 Rockfish in the BSAI are currently managed as two assemblages; 1) Pacific ocean perch complex and 2)
34 other rockfish. The Pacific ocean perch complex includes Pacific ocean perch, rougheye rockfish,
35 shortraker rockfish, sharpchin rockfish, and northern rockfish. For the EBS region, the Pacific ocean
36 perch complex is divided into two subgroups with: 1) Pacific ocean perch, and 2) shortraker, rougheye,
37 sharpchin, and northern rockfish combined. For the Aleutian Islands region, the Pacific ocean perch
38 complex is divided into three subgroups: 1) Pacific ocean perch, 2) shortraker and rougheye rockfish, and
39 3) sharpchin and northern rockfish. Separate ABC, and TAC, and OFLs are assigned to each subgroup.
40 Other rockfish includes all *Sebastes* and *Sebastolobus* species in the BSAI region other than the Pacific
41 ocean perch complex. Shortspine thornyheads account for more than 90 percent of the estimated biomass
42 of the other rockfish assemblage in the BSAI.
43

44 Rockfish are assessed with either an age structured model or trawl survey based model, depending on the
45 management group. Pacific ocean perch are assessed with an age-structured model incorporating fishery
46 and survey catch and age composition data. Most other species of rockfish are assessed based on trawl
47 survey catch data. Survey data are from the NMFS triennial trawl surveys. The stock assessments provide
48 the best available information. For all rockfish management groups, the assessment includes catch

1 history, characterizations of the fishery, assessment methodology, and abundance and exploitation trends.
2 The results of the analyses, which are updated annually, are presented in the GOA and BSAI stock
3 assessment report, which is incorporated into the NPFMC SAFE reports.
4

5 *Pacific ocean perch*

6

7 Pacific ocean perch is primarily a demersal species which inhabits the outer continental shelf and slope
8 regions of the North Pacific and Bering Sea, from southern California to Japan (Allen and Smith 1988).
9 As adults, they live on or near the sea floor, generally in areas with smooth bottoms (Krieger 1993),
10 generally at depths ranging from 180 to 420 m. The diet of Pacific ocean perch appears to consist
11 primarily of plankton (Brodeur and Percy 1984); euphausiids are the single most important prey item
12 (Yang 1996).
13

14 Though more is known about the life history of Pacific ocean perch than about other rockfish species
15 (Kendall and Lenarz 1986), much uncertainty still exists about its life history. Pacific ocean perch are
16 viviparous, with internal fertilization and the release of live young (Hart 1973). Insemination occurs in
17 the fall, and release of larvae occurs in April or May. Pacific ocean perch larvae are thought to be pelagic
18 and drift with the current. Juveniles seem to inhabit rockier, higher relief areas than adults (Carlson and
19 Straty 1981, Krieger 1993). Pacific ocean perch is a slow growing species that, in the Gulf, reaches
20 maturity at approximately 10 years, or 36 cm in length (Heifetz et al. 1997) and has a maximum life span
21 of 90 years (Chilton and Beamish 1982). The natural mortality rate likely is between 0.02 and 0.08
22 (Archibald et al. 1981, Chilton and Beamish 1982).
23

24 Pacific ocean perch is the most commercially important rockfish in Alaska's fisheries and is taken almost
25 exclusively with bottom trawls. The species is highly valued and supported large Japanese and Soviet
26 trawl fisheries throughout the 1960s. Apparently, stocks were not productive enough to support the large
27 removals that took place, and they declined throughout the 1960s and 1970s, reaching their lowest levels
28 in the early 1980s. Since that time, stocks have stabilized in the EBS, and increased in the Aleutian
29 Islands and GOA.
30

31 A time series of fishery and survey age compositions allows the use of an age-based stock assessment
32 model for POP. The outputs include estimates of abundance, spawning biomass, fishery and survey
33 selectivity, exploitation trends, and projections of future biomass. The model uses the ratio of female
34 spawning biomass to that which would exist without fishing to estimate reference fishing mortality rates.
35 The reference fishing mortality rates are used to calculate ABC, and the assessment is updated annually.
36

37 In the GOA, Pacific ocean perch fall into Tier 3 of the ABC/OFL definitions, which requires reliable
38 estimates of biomass, $B_{40\%}$, $F_{30\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the
39 overfishing fishing mortality rate for Pacific ocean perch is the $F_{35\%}$ adjusted rate which is 0.078 for
40 Pacific ocean perch and equates to a yield of 15,385 mt. The maximum allowable fishing mortality rate
41 for ABC (F_{ABC}) defined by Tier 3 is the $F_{40\%}$ adjusted rate which is 0.065 for Pacific ocean perch and
42 translates to a yield of 13,020 mt. The stock assessment fishing mortality rate for ABC is equivalent to
43 the maximum allowable fishing mortality rate. The current Council TAC level is 13,020 mt, equal to the
44 recommended stock assessment ABC.
45

46 The current age and size distributions of Pacific ocean perch in the GOA are discussed in Heifetz et al.
47 (1999). Information is available from the 1984, 1987, 1990, 1993, and 1996 surveys. The dominating
48 factor determining the age composition is the magnitude of the recruiting year classes which are highly

1 variable. The first three surveys show a strong 1976 year-class, and the 1980 year-class appears strong in
2 the 1987 survey and average in the 1990 survey. The 1986 year-class appears strong in the 1990 survey,
3 and exceptionally strong in the 1993 and 1996 surveys. The selectivity of the fishery has cumulative
4 impacts on the age composition due to fishing mortality, and it is not certain how the current age
5 composition of the population would compare to an unfished population.
6

7 In the GOA, the directed fishery for Pacific ocean perch is prosecuted by catcher-processor and catcher
8 bottom trawlers. The percentage of Pacific ocean perch taken by pelagic trawls has increased from 2-8
9 percent during 1990-1995 to 14-20 percent during 1996-1998. Factory trawlers continue to take nearly all
10 the catch in the eastern and western GOA; however, since 1996, the percentage of Pacific ocean perch in
11 the central GOA taken by shore-based trawlers has ranged from 28 percent to 49 percent. The fishery
12 generally occurs at depths between 150 and 300 m along the outer continental shelf, the upper continental
13 slope and at the mouth of gullies. Important Pacific ocean perch fishery locations include: in the eastern
14 GOA, the gully and slope southwest of Yakutat Bay and off Cape Omaney; in the central GOA, the shelf,
15 slope and gullies off of Kodiak Island south of Portlock Bank and near Albatross Bank; and in the
16 western GOA, the shelf and slope south of Unimak and Umnak Islands.
17

18 In the GOA, Pacific ocean perch are caught as bycatch (not necessarily discarded) in other directed
19 fisheries aimed mostly at other species of rockfish. Heifetz and Ackley (1997) analyzed bycatch in
20 rockfish fisheries of the GOA. Bycatch rates of Pacific ocean perch are highest in the pelagic shelf
21 rockfish, "other slope rockfish", and shortspine thornyhead fisheries. Information on bycatch in non-
22 rockfish fisheries has not been analyzed. Recent discard rates (discards/total catch) of Pacific ocean
23 perch have been about 15 percent (Heifetz et al. 1997). In 1997, about 1,360 mt of Pacific ocean perch
24 were discarded compared to a total catch of 9,500 mt.
25

26 The diets of commercially important groundfish species in the GOA during the summer of 1990 were
27 analyzed by Yang (1993). About 98 percent of the total stomach content weight of Pacific ocean perch in
28 the study was made up of invertebrates and 2 percent of fish. Euphausiids (mainly *Thysanoessa inermis*)
29 were the most important prey item. Euphausiids comprised 87 percent by weight of the total stomach
30 contents. Calanoid copepods, amphipods, arrow worms, and shrimp were frequently eaten by POP.
31 Documented predators of Pacific ocean perch include Pacific halibut and sablefish, and it likely that
32 Pacific cod and arrowtooth flounder also prey on POP. Pelagic juveniles are consumed by salmon, and
33 benthic juveniles are eaten by lingcod and other demersal fish.
34

35 In the BSAI, Pacific ocean perch are assessed with an age-structured model incorporating fishery and
36 survey catch data and age compositions. Survey data are from the NMFS triennial trawl groundfish
37 surveys and the fishery data comes from the observer program. The stock assessment is based on the best
38 available information. It includes catch history, characterizations of the fishery, assessment methodology,
39 abundance and exploitation trends, and projected catch and abundance trends for a range of fishing
40 mortalities and recruitment assumptions (Ito et al. 1999). The assessments for the other species in the
41 Pacific ocean perch complex and for the "other rockfish" management category are based on
42 substantially less information (Ito and Spencer 1999, Ito et al. 1999).
43

44 The current spawning biomass for Pacific ocean perch in the Aleutian Islands is about 2,500 mt below its
45 long-term average under an $F_{40\%}$ ($=0.072$) harvest strategy. Our current estimate of spawning biomass for
46 this stock is about 97,800 mt, whereas, the long-term equilibrium spawning biomass is about 100,300 mt.
47 Based on the guidelines established under Tier 3, the adjusted F_{ABC} was calculated as 0.0702, which
48 equates to an ABC estimate of approximately 12,300 mt. The total Aleutian Islands recommended ABC

1 was then apportioned among Aleutian Islands subareas based on survey distribution, as follows: western
2 = 5,670 mt, central = 3,510 mt, and eastern = 3,120 mt. This was done to better distribute fishing effort
3 over a wider area, thereby reducing the chance for localized depletion. The OFL was determined using an
4 adjusted $F_{35\%}$ rate of 0.0826 which translates to an OFL of 14,400 mt.

5
6 For the EBS stock of POP, the estimate of current spawning biomass is also below its long-term average.
7 The current estimate of spawning biomass for this stock is about 24,900 mt and its long-term equilibrium
8 spawning biomass is 26,200 mt. The same adjustment procedure used for the Aleutian Islands $F_{40\%}$ rate
9 was also applied to the EBS $F_{40\%}$ estimate. This procedure produced an F_{ABC} of 0.0544 and an ABC
10 estimate for the EBS of approximately 2,600 mt. The overfishing mortality level (FOFL) was given as an
11 adjusted $F_{35\%}$ and was 0.0653, which translates to an OFL of about 3,100 mt.

12 13 **Shortraker and Rougheye Rockfish**

14
15 Shortraker and rougheye rockfish inhabit the outer continental shelf of the north Pacific from the EBS as
16 far south as southern California (Kramer and O'Connell 1988). Adults of both species are semi-demersal
17 and are usually found in deeper waters (from 50 to 800 m) and over rougher bottoms (Krieger and Ito
18 1999) than POP. Little is known about the biology and life history of these species, but they appear to be
19 long-lived, with late maturation and slow growth. Shortraker rockfish have been estimated to reach ages
20 in excess of 120 years and rougheye rockfish in excess of 140 years. Natural mortality rates have been
21 estimated by Heifetz and Clausen (1991) at 0.025 for rougheye rockfish and 0.030 for shortraker
22 rockfish. Like other members of the genus *Sebastes*, they are viviparous (bear live young) and birth
23 occurs in the early spring through summer (McDermott 1994). Food habit studies conducted by Yang
24 (1993) indicate that the diet of rougheye rockfish is dominated by shrimp. The diet of shortraker rockfish
25 is not well known, based on a small number of samples, the diet appears to be dominated by squid.
26 Because shortraker rockfish have large mouths and short gill rakers, it is possible that they are potential
27 predators of other fish species (Yang 1993). Though shortraker and rougheye rockfish are highly valued,
28 amounts available to the commercial fisheries are limited by relatively small TAC and ABC amounts that
29 are fully needed to support bycatch needs in other groundfish fisheries. As a result, the directed fishery
30 for these species typically is closed at the beginning of the fishing year.

31
32 The primary methods of harvest for shortraker and rougheye rockfishes are bottom trawl and longline
33 gears. The bulk of the commercial harvest usually occurs at depths between 200 and 500 m along the
34 upper continental slope. Both species are associated with a variety of habitats from soft to rocky habitats,
35 although boulders and sloping terrain appear also to be desirable habitat. Age at recruitment is uncertain,
36 but is probably on the order of 20+ years for both species. Length at 50 percent sexual maturity is about
37 45 cm for shortraker rockfish and about 44 cm for rougheye rockfish (McDermott 1994).

38
39 A sufficient time series of fishery and survey age compositions is not available to construct an age-based
40 stock assessment model for shortraker and rougheye rockfish. Thus assessment is based mostly on
41 exploitable biomass estimates provided by trawl surveys. Specifically, exploitable biomass for the GOA
42 stocks is estimated as the unweighted average of the three most recent surveys (1993, 1996, and 1999),
43 excluding the 1-100 m depth stratum (which contains largely unexploitable juvenile fish). Life history
44 information allows estimates of reference fishing mortality rates which are used to calculate ABC. The
45 stock assessment is updated annually.

46
47 In the GOA, shortraker rockfish falls into Tier 5, and rougheye rockfish falls into Tier 4 of the ABC/OFL
48 definitions. Under these definitions, the overfishing fishing mortality rate for shortraker rockfish is the

1 $F=M$ rate of 0.03. The maximum allowable fishing mortality rate for ABC (F_{ABC}) defined by Tier 5 for
2 shorttraker rockfish is the $F=0.75M$ rate which is 0.023. The maximum allowable fishing mortality rate
3 for ABC (F_{ABC}) for rougheye rockfish defined by Tier 4 is $F_{40\%}$ which is 0.032. The stock assessment F_{ABC}
4 for rougheye set equal to the natural mortality M of 0.025, which is lower than the maximum allowable
5 fishing mortality rate for ABC. This results in the recommended ABC of 1,730 mt for shorttraker and
6 rougheye rockfish, and this level was adopted as the ABC and TAC by the Council. Because the
7 shorttraker and rougheye rockfish ABC and TAC are set more conservatively than the maximum
8 prescribed under the definitions, less of a risk of the F_{ABC} rate being an overly aggressive harvest rate for
9 shorttraker and rougheye rockfish exists. This affords more protection to the stocks given the variability
10 and uncertainty associated with the abundance.
11

12 For the Aleutian Islands shorttraker and rougheye rockfish stocks, the assessment is also based on catch
13 and survey data. The biomass estimates from U.S. domestic Aleutian Islands bottom trawl surveys (1991,
14 1994, 1997) are averaged to obtain the best estimate of biomass for the species in this subcomplex;
15 earlier U.S.-Japan cooperative surveys were excluded because of differences in survey gear. The 2000
16 biomass estimates of rougheye and shorttraker rockfish were 12,762 mt and 28,713 mt, respectively. In
17 1996, the Council's Science and Statistical Committee determined that reliable estimates of the natural
18 mortality rate existed for the species in this subcomplex, and that shorttraker and rougheye rockfish in the
19 Aleutian Islands therefore qualified for management under Tier 5. The accepted estimates of M is 0.025
20 for rougheye rockfish and 0.030 for shorttraker rockfish. The Plan Team recommends setting F_{ABC} at the
21 maximum value allowable under Tier 5, which is 75 percent of M . This produced F_{ABC} of 0.019 for
22 rougheye rockfish and 0.023 for shorttraker rockfish. Multiplying these rates by the biomass estimates and
23 summing across species gives a 2000 ABC of 885 mt. The Plan Team's OFL was determined from the
24 Tier 5 formula, where setting $F_{OFL}=M$ for each species gives a combined OFL of 1,180 mt.
25

26 In recent years a directed fishery for shorttraker and rougheye rockfish has not been allowed, because
27 TACs are small. Shorttraker and rougheye rockfishes are often caught as bycatch and retained in the
28 sablefish and halibut longline fisheries and fisheries targeting other species of rockfish. Heifetz and
29 Ackley (1997) analyzed bycatch (not necessarily discarded) in rockfish fisheries of the GOA. Bycatch
30 rates of shorttraker and rougheye rockfish are highest in the shortspine thornyhead and Pacific ocean
31 perch fisheries. An analysis of bycatch rates in non-rockfish fisheries has not been conducted. Discard
32 rates (discards/total catch) of shorttraker and rougheye rockfish in the GOA during 1995 to 1999 have
33 ranged from 22 percent to 32 percent (Heifetz et al. 1999). In 1999, about 397 mt of shorttraker and
34 rougheye rockfish were discarded compared to a total catch of 1,310 mt.
35

36 **Northern Rockfish**

37

38 Northern rockfish inhabit the outer continental shelf from the EBS, throughout the Aleutian Islands and
39 the GOA (Kramer and O'Connell 1988). This species is semi-demersal and is usually found in
40 comparatively shallower waters of the outer continental slope (from 50 to 600 m). Little is known about
41 the biology and life history of northern rockfish. However, they appear to be long lived, with late
42 maturation and slow growth. Heifetz and Clausen (1991) estimated the natural mortality rate for northern
43 rockfish to be 0.060. Like other members of the genus *Sebastes*, they bear live young, and birth occurs in
44 the early spring through summer (McDermott 1994). Food habit studies conducted by Yang (1993)
45 indicate that the diet of northern rockfish is dominated by euphausiids. Although northern rockfish are
46 lower in value than Pacific ocean perch, they still support a valuable directed trawl fishery, especially in
47 the GOA.
48

1 In the GOA, northern rockfish falls into Tier 4 of the ABC/OFL definitions. The exploitable biomass is
2 estimated as the weighted mean from the three most recent surveys; this produces an estimate of 85,357
3 mt for northern rockfish. The maximum allowable fishing mortality rate for ABC (F_{ABC}) defined by Tier
4 4 is the $F_{40\%}$ rate of 0.075. The stock assessment F_{ABC} for rougheye set equal to the natural mortality M of
5 0.06, which is lower than the maximum allowable fishing mortality rate for ABC. This results in the
6 stock assessment ABC of 5,120 mt for northern rockfish. The current Council ABC and TAC levels are
7 4,990 mt. Because the northern rockfish ABC and TAC are more conservative than the maximum
8 prescribed under the definitions, less risk exists of the F_{ABC} rate being an overly aggressive harvest rate
9 for this species. This affords more protection to the stocks given the variability and uncertainty
10 associated with the abundance.
11

12 Age-structured information exists for GOA northern rockfish, and has led to the development of an age-
13 structured population model (Heifetz et al 1999). It is expected that this model will be used for future
14 assessments. The current age and size distributions of Pacific ocean perch in the GOA are discussed in
15 Heifetz et al. (1999). Information is available from the 1984, 1987, 1990, 1993, and 1996 surveys. The
16 dominating factor determining the age composition is the magnitude of the recruiting year classes which
17 are highly variable. Most surveys (except the 1993 survey) indicate that 1968-1971 and 1975-1977 were
18 periods of strong year-classes. The 1993 and 1996 surveys indicate that the 1984 and 1985 year-classes
19 may be stronger than average. The selectivity of the fishery has cumulative impacts on the age
20 composition due to fishing mortality, and it is not certain how the current age composition of the
21 population would compare to an unfished population.
22

23 The directed fishery for northern rockfish is prosecuted by catcher-processor and catcher bottom
24 trawlers. As with the Pacific ocean perch fishery, a higher percentage of the catch in the central GOA is
25 being taken by shore-based trawlers, ranging from 32 percent to 53 percent from 1996 to 1999. The
26 patterns of the fishery generally reflect the distribution of the species. The fishery is concentrated at
27 discrete, relatively shallow offshore banks of the outer continental shelf at depths between 75 and 125 m.
28 Important northern rockfish fishery locations include Portlock Bank and Albatross Bank south of Kodiak
29 Island, Shumagin Bank south of the Shumagin Islands, and Davidson Bank south of Unimak Island.
30

31 Heifetz and Ackley (1997) analyzed bycatch (not necessarily discarded) in rockfish fisheries of the GOA.
32 Bycatch rates of northern rockfish are highest in the pelagic shelf rockfish, "other slope rockfish", and
33 Pacific ocean perch fisheries. Information on bycatch of northern rockfish in non-rockfish fisheries has
34 not been analyzed. Discard rates (discards/total catch) of the GOA northern rockfish from 1995 to 1999
35 have ranged from 13 percent to 28 percent (Heifetz et al. 1999). In 1999, about 597 mt of northern
36 rockfish were discarded compared to a total catch of 5297 mt.
37

38 Northern rockfish are generally planktivorous (feed on plankton) with euphausiids being the predominant
39 prey item (Yang 1993). Copepods, hermit crabs, and shrimp have also been noted as prey items in much
40 smaller quantities. Predators of northern rockfish are not well documented but likely include larger fish
41 such as Pacific halibut that are known to prey on other rockfish species.
42

43 In the Aleutian Islands, northern rockfish are managed together with sharpchin rockfish. Because
44 sharpchin rockfish are found only rarely in the Aleutian Islands, northern rockfish are, for all practical
45 purposes, the only species in this subcomplex. As with the shortraker and rougheye stocks, the biomass
46 estimates from U.S. domestic Aleutian Islands bottom trawl surveys (1991, 1994, 1997) are averaged to
47 obtain the best estimate of biomass for the species in this subcomplex. This procedure produced a
48 biomass estimate of 114,501 mt. Northern rockfish in the Aleutian Islands are managed under Tier 5 of

1 Amendment 44. The accepted estimate of M for northern rockfish in the Aleutian Islands is 0.06. ABC
2 was based on maximum allowable F_{ABC} under Tier 5, which is 75 percent of M , or 0.045. Multiplying this
3 rate by the best estimate of biomass gave a 2000 ABC of 5,153 mt. The Plan Team's OFL was
4 determined from the Tier 5 formula, where setting $F_{OFL}=M$ gives a 2000 OFL of 6870 mt.

5 6 **Pelagic Shelf Rockfish**

7
8 In the GOA, pelagic shelf rockfish consist of dusky rockfish, yellowtail rockfish, and widow rockfish.
9 Black rockfish were formerly in this group, but were removed in April, 1998, from both the pelagic shelf
10 group and the GOA groundfish FMP. Dusky rockfish is by far the most important species in the group,
11 both in terms of abundance and commercial value. This complex is assessed with a trawl survey-based
12 model, with survey data coming from the NMFS GOA triennial trawl surveys. The stock assessments
13 provide the best available information for pelagic shelf rockfish, and include discussions of catch history,
14 characterizations of the fishery, assessment methodology, and abundance and exploitation trends. The
15 results of the analyses, which are updated annually, are presented in the GOA pelagic shelf rockfish stock
16 assessment which is incorporated into the GOA SAFE report.

17
18 Pelagic shelf rockfish fall into Tier 4 of the current ABC/OFL definitions, which requires estimates of
19 biomass, $F_{35\%}$, and $F_{40\%}$. Biomass estimates are produced from averaging the three most recent triennial
20 surveys (1993, 1996, and 1999), and the current exploitable biomass is 66,443 mt. Estimates of $F_{35\%}$ and
21 $F_{40\%}$ are derived using life history parameters for dusky rockfish. According to the definitions for Tier 4,
22 the maximum allowable fishing mortality rate for ABC (F_{ABC}) is the $F_{40\%}$ rate, which is 0.11 for pelagic
23 shelf rockfish and translates to a Gulfwide yield of 7,309 mt. The actual stock assessment F_{ABC} for
24 pelagic shelf rockfish, however, is set to a more conservative value, $F=M$, in which F_{ABC} equals the
25 natural mortality of dusky rockfish, 0.090. Hence, the corresponding yield is 5,980 mt, which is the
26 recommended ABC value in the stock assessment for 2000. The Council has adopted this level for both
27 the ABC and TAC for 2000. The corresponding OFL fishing mortality rate is $F_{35\%} = 0.136$, which results
28 in an OFL yield of 9036 mt. Because the northern rockfish ABC and TAC are more conservative than the
29 maximum prescribed under the definitions, less risk exists of the F_{ABC} rate being an overly aggressive
30 harvest rate for this species. This affords more protection to the stocks given the variability and
31 uncertainty associated with the abundance.

32
33 Age and size distributions of dusky rockfish are based on results of the five triennial trawl surveys from
34 1984 to 1996, and are discussed in Clausen and Heifetz (1999). Age results are only available from the
35 1987, 1990, and 1993 surveys, and these show that substantial recruitment of dusky rockfish appears to
36 be a relatively infrequent event. Strong year classes are only seen for 1976 to 1977, 1979 to 1980, and
37 1986. The size compositions from each of the five surveys indicate that recruitment of small fish to the
38 survey occurred only in 1993, corresponding to the 1986 year class. The effects of fishing on the age and
39 size compositions are unknown, as no age or size data are available from either the fishery, or the
40 unfished population prior to the beginning of the fishery.

41
42 Dusky rockfish are caught almost exclusively with bottom trawls. Factory trawlers dominated the
43 directed fishery from 1988 to 1995. Since 1996, the percentage of the catch taken by shore-based trawlers
44 in the central GOA has ranged from 18 percent to 45 percent. Catches are concentrated at a number of
45 relatively shallow, offshore banks of the outer continental shelf, especially the "W" grounds west of
46 Yakutat, and Portlock Bank. Other fishing grounds include Albatross Bank, the "Snakehead" south of
47 Kodiak Island, and Shumagin Bank. Highest catch per unit effort is generally taken at depths of 10-150 m
48 (Reuter 1998).

1 Dusky rockfish often co-occur with northern rockfish, and they are caught as bycatch in the northern
2 rockfish and “other slope rockfish” fisheries (Heifetz and Ackley 1997). To a lesser extent, they are also
3 taken as bycatch in the Pacific ocean perch fishery. Overall discard rates (discards/total catch) of dusky
4 rockfish in recent years have been quite low, generally 10 percent or less (Clausen and Heifetz 1999).

5
6 Trophic interactions of dusky rockfish are not well known. Food habits information is available from just
7 one study with a relatively small sample size for dusky rockfish (Yang 1993). This study indicated that
8 adult dusky rockfish consume primarily euphausiids, followed by larvaceans, cephalopods, and pandalid
9 shrimp. Predators of dusky rockfish have not been documented, but likely include species that are known
10 to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

11 **Demersal Shelf Rockfish**

12
13
14 Demersal shelf rockfish include seven species of nearshore, bottom-dwelling rockfish: canary rockfish,
15 China rockfish, copper rockfish, quillback rockfish, rosethorn rockfish, tiger rockfish, and yelloweye
16 rockfish. Demersal shelf rockfish are managed by the Council as a distinct assemblage only off Southeast
17 Alaska Outside (SEO) east of 140°W, an area which is further divided into four management units along
18 the outer coast: the South SEO (SSEO), central SEO (CSEO), North SEO (NSEO), and East Yakutat
19 (EYKT). Yelloweye rockfish comprise 90 percent of the catch and will be the focus of this section.

20
21 Yelloweye rockfish occur on the continental shelf from northern Baja California to the EBS, commonly
22 in depths less than 200 m (Kramer and O'Connell 1988). They are long-lived, slow growing, and late
23 maturing. Yelloweye have been estimated to reach 118 years and their natural mortality rate is estimated
24 at 0.20 (O'Connell and Funk 1987). They are viviparous (live bearing) with parturition (birth) occurring
25 primarily in late spring through mid-summer (O'Connell 1987). Yelloweye inhabit areas of rugged, rocky
26 relief and adults appear to prefer complex bottoms with the presence of “refuge spaces” (O'Connell and
27 Carlile 1993). Demersal shelf rockfish are highly valued and a directed longline fishery is held for these
28 species. However, yelloweye are the primary bycatch in the halibut fishery and therefore a large portion
29 of the TAC and ABC are set aside for bycatch. In 1998, 31 percent of the total Demersal shelf rockfish
30 landings occurred as bycatch in the halibut fishery (O'Connell et al. 1999).

31
32 Traditional abundance estimation methods (e.g., area-swept trawl surveys, mark recapture) are not
33 considered useful for these fishes given their distribution, life history, and physiology. However,
34 ADF&G is continuing research to develop and improve a stock assessment approach for them. As part of
35 that research a manned submersible, R/V Delta, is used to conduct line transects (Buckland et al. 1993,
36 Burnham et al. 1980). Density estimates are limited to adult yelloweye, because it is the principal species
37 targeted and caught in the fishery, and therefore ABC/TAC recommendations for the entire assemblage
38 are keyed to adult yelloweye abundance. Total yelloweye rockfish biomass is estimated for each
39 management subdistrict as the product of density, mean weight of adult yelloweye, and areal estimates of
40 Demersal shelf rockfish habitat (O'Connell and Carlile 1993). For estimating variability in yelloweye
41 biomass, log-based confidence limits are used because the distribution of density tends to be positively
42 skewed and density is assumed to be log-normal (Buckland et al. 1993). Estimation of both line length
43 for the transects and total area of rocky habitat are difficult and result in some uncertainty in the biomass
44 estimates. Density estimates were made in the EYKT and SSEO areas in 1999. The density in the SSEO
45 area increased 38 percent from the previous density estimate made in 1994, although some of this change
46 may be due to increased sample size and a change in survey techniques. In contrast, the density in the
47 EYKT area decreased 44 percent from the previous estimate in 1997. During the 1997 survey, the area
48 estimate of rock habitat in the EYKT management area was reduced by 60 percent compared to past

1 assessments, resulting in a reduction in the biomass estimate for this area. The sum of the lower 90
2 percent confidence limits of biomass, by area, is the reference number for setting ABC because of the
3 continued uncertainty in yelloweye biomass estimation. This resulted in a biomass estimate of 15,100 mt
4 for 2000.

5
6 Demersal shelf rockfish falls into Tier 4 of the ABC/OFL definitions. Under these definitions, the OFL
7 mortality rate is $F_{35\%}=0.028$ (420 mt), and the maximum allowable fishing mortality rate for ABC is the
8 $F_{40\%}=0.025$. However, a more conservative approach has been taken for setting ABC and TAC. By
9 applying $F=M=0.02$ to yelloweye rockfish biomass and adjusting for the 10 percent of other Demersal
10 shelf rockfish species, the recommended 2000 ABC is 340 mt. Continued conservatism in managing this
11 fishery is warranted given the life history of the species and the uncertainty of the biomass estimates.

12
13 The age and size distributions of yelloweye rockfish are discussed in O'Connell et al. (1999) and
14 O'Connell and Funk (1987). Estimated length and age at 50 percent maturity for yelloweye collected in
15 CSEO in 1988 are 45 cm and 21 years for females and 50 cm and 23 years for males. Age of first
16 recruitment into the fishery is between 13 and 18 years. The most recent age data is from the 1998
17 commercial catch samples. In the CSEO, the area with the longest catch history, the 1997 distribution
18 shows a strong mode at 28 years of age, with some younger modes. The older ages have declined in
19 frequency over time and the average age continues to decline and remains the lowest of all areas. In the
20 SSEO, the 1997 age data shows pronounced modes at 16 and 20 years, with the older ages contributing
21 less. In EYKT, the 1998 age distribution is multimodal, the largest mode at 29-30 years, and smaller
22 modes at 33 and 40 years. Unlike other areas, no sign of recruitment is seen here. The effects of fishing
23 on the age and size compositions are unknown, as no age or size data are available from either the
24 fishery, or the unfished population prior to the beginning of the fishery.

25
26 The directed fishery for Demersal shelf rockfish is prosecuted by longliners. Yelloweye rockfish occur in
27 areas of rugged, rocky bottom, commonly between 100 and 200 m. The lava fields off Cape Edgecumbe
28 in CSEO and the offshore Fairweather Ground in EYKT are the most important fishing areas. A small
29 amount of Demersal shelf rockfish are taken as bycatch in jig and troll fisheries. Trawling is prohibited in
30 the eastern GOA. Yelloweye rockfish is the dominant bycatch species in the halibut longline fishery. The
31 majority of the longline vessels in the eastern GOA are unobserved so it is difficult to get an accurate
32 accounting of discards at sea. For the past several years we have estimated unreported mortality of
33 Demersal shelf rockfish during the halibut fishery based on International Pacific Halibut Commission
34 (IPHC) interview data. The 1993 interview data indicates a total mortality of Demersal shelf rockfish of
35 13 percent of the June halibut landings (by weight) and 18 percent of the September halibut landings.
36 Unreported mortality data has been more difficult to collect under the halibut IFQ fishery and appears to
37 be less reliable than previous data. The allowable bycatch limit of Demersal shelf rockfish during halibut
38 fishing is 10 percent of the halibut weight. The total bycatch of Demersal shelf rockfish during the 1999
39 halibut fishery in the eastern Gulf is estimated to be 184 mt, much of which is unreported. Catch statistics
40 do not accurately reflect true mortality of Demersal shelf rockfish.

41
42 Yelloweye are a large, predatory fish that usually feeds close to the bottom. Food habit studies indicate
43 that the diet of yelloweye rockfish is dominated by fish remains, which comprised 95 percent, by volume,
44 of the stomachs analyzed. Herring, sandlance and Puget Sound rockfish were particularly dominant.
45 Shrimp are also an important prey item (Rosenthal et al. 1988).

46 **Thornyheads**

1 Thornyheads in Alaskan waters are comprised of two species, the shortspine thornyhead and the
2 longspine thornyhead. Only the shortspine thornyhead is of commercial importance. It is a demersal
3 species found in deep water from 93 to 1,460 m from the Bering Sea to Baja California (Ianelli and
4 Gaichas 1999). Little is known about thornyhead life history. Like other rockfish, they are long lived and
5 slow growing. The maximum recorded age is probably in excess of 50 years, and females do not become
6 sexually mature until an average age of 12 to 13 at a length of about 21 cm. Thornyheads spawn large
7 masses of buoyant eggs during the late winter and early spring (Pearcy 1962). Juveniles are pelagic for
8 the first year. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads
9 in the GOA; while cottids were the most important prey item in the Aleutian Islands region. Until
10 recently, thornyheads were not targeted by the commercial fishery. However, they are now among the
11 most valuable rockfish species and are harvested by trawl and longline gear. Most of the domestic
12 harvest is exported to Japan. Thornyheads are taken with some frequency in the longline fishery for
13 sablefish, and cod and are often part of the bycatch of trawlers concentrating on pollock and other
14 rockfish species.

15
16 In the GOA, shortspine thornyheads are assessed with an age-structured model incorporating data from
17 two fisheries (longline and trawl) and two types of survey data. Bottom trawl surveys have been
18 conducted every three years in the GOA during June through August and provide a limited time-series of
19 abundance since 1977. Longline surveys occur annually and extend into the deeper waters (300 – 800 m)
20 of shortspine thornyhead habitat. Both surveys provide estimates of the size distributions of their
21 respective catches. These are used in the stock assessment model in place of age compositions because
22 extensive age-determinations on this species are currently impractical, given the difficulties in
23 interpretation of their otoliths. Biologically, the biggest area of uncertainty for this species is in their
24 longevity and natural mortality rate. Currently, NMFS scientists believe they are slow-growing and long-
25 lived fish that are relatively sedentary on the ocean floor. Survey and fishery catch rates indicate that they
26 are relatively evenly distributed within their habitat and do not tend to form dense aggregations like many
27 other groundfish species. This distribution pattern is important in interpreting the survey results because
28 the assumptions implied in “area-swept” methods for the bottom trawl gear are likely to be satisfied.
29 Fishery data include estimates of the total catch and size distribution information by gear type. The
30 estimated biomass for 2000 is 23,084 mt, and the recommended ABC is 2,360 mt. The Council has
31 adopted this value for both the 2000 TAC and OFL harvest levels.

32
33 In the EBS and Aleutian Islands, thornyheads are managed as part of the “other rockfish” management
34 assemblage. Shortspine thornyheads are the primary species in the “other rockfish” management
35 assemblage. The assessment is based on the most recent catch and survey data. Traditionally, the biomass
36 estimates (split according to management area) from all bottom trawl surveys (EBS shelf/slope and
37 Aleutian Islands) are averaged over all years to obtain the best estimates of biomass for the species in this
38 complex. In 1999, this procedure produced a biomass estimate of 7,030 mt in the EBS, and a biomass
39 estimate of 13,000 mt in the Aleutian Islands. The great majority of this biomass is comprised of
40 thornyhead rockfish. In 1996, the SSC determined that a reliable estimate of the natural mortality rate
41 existed for the species in this subcomplex, and that “other rockfish” in the EBS and Aleutian Islands
42 therefore qualified for management under Tier 5 (Appendix 1; Amendment 44). The accepted estimate of
43 M for these species in both areas is 0.07. F_{ABC} was set at the maximum value allowable under Tier 5,
44 which is 75 percent of M , or 0.053. Multiplying this rate by the best estimate of complex-wide biomass
45 gives an ABC of 369 mt in the EBS and 685 mt in the Aleutian Islands. The Plan Team’s OFLs were
46 determined from the Tier 5 formula, where setting $F_{OFL}=M$ gives an OFL of 492 mt in the EBS and 913
47 mt in the Aleutian Islands.

1 Other Rockfish Species

2
3 Numerous other rockfish species of the genus *Sebastes* have been reported in the GOA and BSAI
4 (Eschmeyer et al. 1984), and several are of commercial importance. Most are demersal or semi-demersal
5 with different species occupying different depth strata (Kramer and O'Connell 1988). All are viviparous
6 (Hart 1973). Life history attributes of most of these rockfish are poorly known or virtually unknown.
7 Because they are long lived and slow growing, natural mortality rates are probably low (less than 0.10).
8 The diet of species for which dietary information exists seems to consist primarily of planktonic
9 invertebrates (Yang 1993, 1996). Other rockfish species are taken both in directed fisheries and as
10 bycatch in trawl and longline fisheries.
11

12 In the GOA, although the “other slope rockfish” management group comprises 17 species, six species
13 alone make up 95 percent of the catch and estimated abundance. These six species are sharpchin,
14 redstripe, harlequin, yellowstripe, silvergrey, and redbanded rockfish. Sharpchin rockfish falls into Tier
15 4, and the remaining species fall into Tier 5 of the ABC/OFL definitions. The overfishing fishing
16 mortality rate for the other species is the $F=M$ rate of 0.10 for redstripe rockfish, 0.04 for silvergrey
17 rockfish, and 0.06 for all the other species (except sharpchin rockfish). The F_{ABC} for sharpchin rockfish is
18 $F=M=0.05$, which is less than the maximum allowable rate of $F_{40\%} = 0.055$. For the other species the
19 maximum allowable fishing mortality rate for ABC is the $F=0.75M$ rate which is 0.075 for redstripe
20 rockfish, 0.030 for silvergrey rockfish, and 0.045 for the remaining species. These rates result in the
21 recommended stock assessment ABC of 4,900 mt for “other slope rockfish”. The current Council ABC
22 and TAC levels are equivalent to this value. Because the ABC and TAC for sharpchin rockfish
23 component of the “other slope rockfish” are more conservative than the maximum prescribed under the
24 definitions, less risk exists of the F_{ABC} rate and TAC being an overly aggressive harvest rate for “other
25 slope rockfish.” This affords more protection to the stocks, given the variability and uncertainty
26 associated with the abundance.
27

28 Heifetz and Ackley (1997) analyzed bycatch (not necessarily discarded) in rockfish fisheries of the GOA.
29 Bycatch rates of “other slope rockfish” are highest in the pelagic shelf rockfish and Pacific ocean perch
30 fisheries. Information on bycatch of “other slope rockfish” in non-rockfish fisheries has not been
31 analyzed. Discard rates (discards/total catch) of “other slope rockfish” from 1995 to 1999 have ranged
32 from 52 percent to 76 percent (Heifetz et al. 1999). In 1999, about 544 mt of “other slope rockfish” were
33 discarded compared to a total catch of 789 mt. High discard rates are seen because many species of
34 “other slope rockfish” are small in size and of low economic value, and fishermen have little incentive to
35 retain these fish.
36

37 Prey of “other slope rockfish” is not documented for the GOA. Predators of “other slope rockfish” are
38 also not well documented, but likely include larger fish such as Pacific halibut that are known to prey on
39 other rockfish species.
40

41 **Atka Mackerel**

42 *BSAI*

43
44 Atka mackerel are distributed from the east coast of the Kamchatka Peninsula, throughout the Aleutian
45 Islands and the EBS, and eastward through the GOA to southeast Alaska (Wolotira et al. 1993). Their
46 current center of abundance is in the Aleutian Islands, with marginal distributions extending into the
47 southern Bering Sea and into the western GOA (Lowe and Fritz, 1999a). Atka mackerel are one of the
48

1 most abundant groundfish species in the Aleutian Islands where they are the target of a directed trawl
2 fishery (Lowe and Fritz 1999a). Adults are semi-pelagic and spend most of the year over the continental
3 shelf in depths generally less than 200 m. Adults migrate annually to shallow coastal waters during
4 spawning, forming dense aggregations near the bottom (Morris 1981, Musienko 1970). In Russian
5 waters, spawning peaks in mid-June (Zolotov 1993) and in Alaskan waters in July through October
6 (McDermott and Lowe 1997). Females deposit adhesive eggs in nests or rocky crevices. The nests are
7 guarded by males until hatching occurs (Zolotov 1993). The first *in situ* observations of spawning habitat
8 in Seguam Pass were recently (August, 1999) documented (pers. comm. Robert Lauth, AFSC). Genetic
9 studies indicate that Atka mackerel form a single stock in Alaskan waters (Lowe et al. 1998). However,
10 growth rates can vary extensively among different areas (Kimura and Ronholt 1988, Lowe et al. 1998,
11 Lowe and Fritz 1999a). Age and size at 50 percent maturity has been estimated at 3.6 years and 33 to 38
12 cm, respectively (McDermott and Lowe 1997). Atka mackerel are a relatively short-lived groundfish
13 species. A maximum age of 15 years has been noted, however most of the population is probably less
14 than 10 years old. Natural mortality estimates vary extensively, and estimates have ranged from 0.12 to
15 0.74 as determined by various methods (Lowe and Fritz 1999a). For stock assessment purposes, a value
16 of 0.3 is used (Lowe and Fritz 1999a).

17
18 Atka mackerel are an important component in the diet of other commercial groundfish, mainly
19 arrowtooth flounder, Pacific halibut, and Pacific cod; seabirds, mainly tufted puffins; and marine
20 mammals, mainly northern fur seals and Steller sea lions (Byrd et al. 1992, Fritz et al. 1995, Livingston et
21 al. 1993, Yang 1996). Atka mackerel are also components in the diets of the following marine mammals
22 and seabirds: harbor seals, Dall's porpoise, thick-billed murre, and horned puffins (Yang 1996). The diets
23 of commercially important groundfish species in the Aleutian Islands during the summer of 1991 were
24 analyzed by Yang (1996). More than 90 percent of the total stomach contents weight of Atka mackerel in
25 the study was made up of invertebrates, with less than 10 percent made up of fish. Euphausiids were the
26 most important prey item, followed by calanoid copepods. Euphausiids comprised 55 percent by weight
27 of the total stomach contents, and copepods comprised 17 percent of the total stomach contents weight.
28 Larvaceans and hyperiid amphipods had high frequencies of occurrence (81 percent and 68 percent,
29 respectively), but comprised less than 8 percent of the total stomach contents weight. Squid was another
30 item in the diet of Atka mackerel; it had a frequency of occurrence of 31 percent, but only comprised 8
31 percent of the total stomach contents weight. Atka mackerel are known to eat their own eggs. Yang
32 (1996) found that Atka mackerel eggs comprised 3 percent of the total stomach contents weight and
33 occurred in 9 percent of the Atka mackerel stomachs analyzed. Walleye pollock were the second most
34 important prey fish of Atka mackerel, comprising about 2 percent of the total stomach contents weight.
35 Myctophids, bathylagids, zoarcids, cottids, stichaeids, and pleuronectids were minor components of the
36 Atka mackerel diet; each category comprised less than 1 percent of the total stomach contents.

37
38 Atka mackerel are a difficult species to survey because they do not have a swim bladder, and therefore
39 are poor targets for hydroacoustic surveys. They prefer rough and rocky bottoms that are difficult to
40 sample with the current survey gear, and their schooling behavior and patchy distribution result in survey
41 estimates with large variances. Complicating the difficulty in surveying Atka mackerel is the low
42 probability of encountering schools in the GOA where the abundance is lower and their distribution is
43 patchier relative to the BSAI. Because of this, it has not been possible to estimate trends in population for
44 the species in the GOA. The stock assessment in the Aleutian Islands is based on the triennial trawl
45 survey as well as total catch and catch at age data from the commercial fishery.

46
47 BSAI Atka mackerel are assessed with an age-structured model incorporating fishery and survey catch
48 data and age compositions. Survey data are from the NMFS Aleutian Islands triennial trawl groundfish

1 surveys. Fishery catch statistics (including discards) are estimated by the NMFS Regional Office. These
2 estimates are based on the best blend of observer reported catch and weekly production reports. The
3 stock assessment includes catch history, characterizations of the fishery, key life history parameters,
4 survey and model estimated abundance trends, historical exploitation rates, reference fishing mortality
5 rates, projected catch and abundance trends for a range of fishing mortalities and recruitment
6 assumptions, and a recommended harvest rate and catch for the upcoming year. The results of the
7 analyses, which are updated annually, are presented in the BSAI Atka mackerel stock assessment which
8 is incorporated into the BSAI SAFE report.

9
10 In 1999, Atka mackerel fell into Tier 3a of the ABC/OFL definitions, which requires reliable estimates of
11 biomass, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing fishing
12 mortality rate is the $F_{35\%}$ rate which was estimated to be 0.42 for Atka mackerel and equated to a yield of
13 119,300 mt (Lowe and Fritz 1999a). The maximum allowable fishing mortality rate for ABC (F_{ABC}) is the
14 $F_{40\%}$ rate which was estimated to be 0.35 for Atka mackerel in 1999, which translated to a yield of
15 102,700 mt (Lowe and Fritz 1999a). In 1999, the stock assessment ABC recommendation for the 2000
16 Atka mackerel fishery was below the maximum rate prescribed under Tier 3a, to provide a more
17 risk-averse harvest rate and to accommodate uncertainty. The stock assessment F_{ABC} is 0.23 which
18 translated to a yield of 70,800 mt. A recommendation lower than $F_{40\%}$ was recommended in the 1999
19 stock assessment because: 1) stock size as estimated by the age-structured analysis has declined by
20 approximately 60 percent since 1991; and 2) the 1997 Aleutian trawl survey biomass estimate was about
21 50 percent lower than the 1991 and 1994 survey estimates.

22
23 The 1998 age and size distributions of BSAI Atka mackerel are discussed in Lowe and Fritz (1999a). The
24 age composition is dominated by a recent strong 1992 year class (6-year- olds), and there is still evidence
25 of the strong 1988 year class (10-year- olds) in the population. The estimated mean age of the 1998
26 fishery age composition is six years. The current fishery tends to select fish ages 3 to 12 years old (Lowe
27 and Fritz 1999a). It is not known how the age composition of the population would look in an unfished
28 population.

29
30 The directed fishery for Atka mackerel is prosecuted by catcher-processor bottom trawlers. The patterns
31 of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring
32 in the same few locations each year, generally occurs at depths between 100 and 200 m (Lowe and Fritz
33 1999a). Important Atka mackerel fishery locations include Seguam Bank, Tanaga Pass, north of the
34 Delarof Islands, Petrel Bank, south of Amchitka Island, east and west of Kiska Island, and on the
35 seamounts and reefs near Buldir Island.

36
37 Since 1979, the Atka mackerel fishery has occurred largely within areas designated as Steller sea lion
38 critical habitat. While total removals from critical habitat may be small in relation to estimates of total
39 Atka mackerel biomass in the Aleutian Islands region, fishery harvest rates in localized areas may have
40 been high enough to affect prey availability of Steller sea lions (Lowe and Fritz 1997). The localized
41 pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next,
42 since local populations in the Aleutian Islands appear to be replenished by immigration and recruitment.
43 However, this pattern could create temporary reductions in the size and density of localized Atka
44 mackerel populations, which could affect Steller sea lion foraging success during the time the fishery is
45 operating and for a period of unknown duration after the fishery is closed.

46
47 To address the possibility that the fishery creates localized depletions of Atka mackerel and adversely
48 modifies Steller sea lion critical habitat by disproportionately removing prey, the Council, in June 1998,

1 passed a fishery management regulatory amendment which proposed a four-year timetable to temporally
 2 and spatially disperse and reduce the level of Atka mackerel fishing within Steller sea lion critical habitat
 3 in the BSAI. The temporal dispersion is accomplished by dividing the BSAI Atka mackerel TAC into two
 4 equal seasonal allowances. The first allowance is made available for directed fishing from January 1 to
 5 April 15 (A season), and the second seasonal allowance is made available from September 1 to
 6 November 1 (B season). The spatial dispersion is accomplished through maximum catch percentages of
 7 each seasonal allowance that can be caught within Steller sea lion critical habitat (CH) as specified for
 8 the central and western Aleutian Islands. No critical habitat closures are established for the eastern
 9 subarea, but the 20 nm trawl exclusion zones around the Seguam and Agligadak rookeries that have been
 10 in place only for the pollock A-season, are in effect year-round. The regulations implementing these
 11 management changes became effective January 22, 1999. The four-year timetable for spatial dispersion
 12 of the Atka mackerel fishery outside of critical habitat is:

Aleutian Island District

Year(s)	Area 541		Area 542		Area 543	
	<i>Inside CH</i>	<i>Outside CH</i>	<i>Inside CH</i>	<i>Outside CH</i>	<i>Inside CH</i>	<i>Outside CH</i>
1999			80%	20%	65%	35%
2000			67%	33%	57%	43%
2001			54%	46%	49%	51%
2002			40%	60%	40%	60%

23 Relative to 1998, the biggest shift in the distribution of fishing effort was observed in area 542 where
 24 effort shifted to Petral Bank in 1999.

25
 26 Atka mackerel are not commonly caught as bycatch in other directed fisheries. The largest amounts of
 27 discards of Atka mackerel, which are likely undersize fish, occur in the directed Atka mackerel trawl
 28 fisheries. Recent discard rates (discards/retained catch) of Atka mackerel in the directed fishery have
 29 been below 10 percent (Lowe and Fritz 1999a). Atka mackerel are also caught as bycatch in the trawl
 30 Pacific cod and rockfish (primarily Pacific ocean perch, sharpchin and northern rockfish) fisheries. It is
 31 difficult to discern the level of natural bycatch of Atka mackerel in the rockfish fisheries, as vessels may
 32 actually be targeting Atka mackerel in particular hauls, but overall they are designated as targeting
 33 rockfish on a particular trip. In 1998, 4,597 mt of Atka mackerel were discarded in the directed fishery as
 34 compared to 1,072 mt discarded in all other fisheries.

35
 36 *GOA*

37
 38 No reliable estimate exists of current Atka mackerel biomass in the GOA. Atka mackerel have not been
 39 commonly caught in each of the GOA triennial trawl surveys. It has been determined that the general
 40 GOA groundfish bottom trawl survey does not assess the Gulf portion of the Atka mackerel stock well,
 41 and the resulting biomass estimates have little value as absolute estimates of abundance or as indices of
 42 trend (Lowe and Fritz 1999b). Because of this lack of fundamental abundance information GOA Atka
 43 mackerel are not assessed with a model and the assessment does not utilize abundance estimates from the
 44 trawl survey. The stock assessment for GOA Atka mackerel consists of descriptions of catch history,

1 length and age distributions from the fishery during 1990 to 1994, and length and age distributions from
2 the trawl surveys (1990, 1993, and 1996). This information is presented in the GOA Atka mackerel stock
3 assessment, which is incorporated into the GOA SAFE report.
4

5 GOA Atka mackerel fall into Tier 6 of the ABC/OFL definitions, which defines the overfishing level as
6 the average catch from 1978 to 1995, and that ABC cannot exceed 75 percent of the OFL. The average
7 annual catch from 1978-95 is 6,200 mt; thus ABC cannot exceed 4,700 mt. The current ABC
8 recommendation from the stock assessment is below the maximum prescribed under Tier 6, to provide a
9 very risk-averse harvest rate given the uncertainty about GOA Atka mackerel. The 1999 stock assessment
10 for the 2000 fishery, recommended an ABC of 600 mt, with the intention of precluding a directed fishery,
11 but providing for bycatch needs in other trawl fisheries. An ABC lower than the maximum prescribed
12 under Tier 6 was recommended because: 1) When past ABCs were lower than 4,700 mt (approximately
13 3,000 mt in 1994), it was shown that the fishery might have created localized depletions of Atka
14 mackerel even at those catch levels [appendix in (Lowe and Fritz 1996)]. This analysis indicated that the
15 fishery was very efficient in removing fish from local areas and at rates which far surpassed the target
16 harvest rate. 2) Analyses of local fishery catch per unit effort indicated that the Atka mackerel
17 populations may have declined significantly between 1992 and 1994 (appendix in Lowe and Fritz 1996),
18 reflecting the trend of the Aleutian Islands Atka mackerel population during that period, which has
19 continued to decline since 1994 (Lowe and Fritz 1999b). 3) The GOA Atka mackerel population appears
20 to be particularly vulnerable to fishing pressure because of sporadic movement of fish eastward from the
21 Aleutian Islands.
22

23 Age and size distributions of GOA Atka mackerel are discussed in Lowe and Fritz (1999b). The most
24 recent size and age distributions are from the 1996 and 1993 trawl surveys, respectively. Male and female
25 size distributions had mean lengths of 45 and 47 cm, respectively. A mode of fish from 45 to 47 cm
26 represented the 1988 year class. It appears as though little recent recruitment has occurred in the GOA
27 population. Currently, no directed fishery for GOA Atka mackerel occurs. Atka mackerel are caught as
28 bycatch, and the selectivity of Atka mackerel by the other fisheries is unknown. As such, Atka mackerel
29 in the GOA are currently managed as a bycatch fishery. They are caught as bycatch in the pollock,
30 Pacific cod, Pacific ocean perch, and northern rockfish fisheries. The low level of TAC likely precludes
31 directed targeting of Atka mackerel on a haul by haul basis, and the catches of Atka mackerel in other
32 directed fisheries may represent true bycatch of Atka mackerel.
33

34 The diets of commercially important groundfish species in the GOA during the summer of 1990 were
35 analyzed by Yang (1993). Atka mackerel were not sampled as a predator species. However, it is probably
36 a reasonable assumption that the major prey items of GOA Atka mackerel would likely be euphausiids
37 and copepods as was found in Aleutian Islands Atka mackerel (Yang 1996). The abundance of Atka
38 mackerel in the GOA is much lower compared to the Aleutian Islands. Atka mackerel only showed up as
39 a minor component in the diet of arrowtooth flounder in the GOA (Yang 1993).
40

41 **Squid and Other Species**

42

43 Squid are found throughout the Pacific Ocean. They are not currently the target of groundfish fisheries in
44 the GOA or BSAI, though they are taken as bycatch in trawl fisheries for pollock and rockfish. The red
45 (magistrate) armhook squid is probably the best known species found in Alaskan waters. It is abundant
46 over continental slopes throughout the North Pacific from Oregon to southern Japan (Nesis 1987). It is
47 the basis of fisheries in both Russian and Japanese waters. Little is known about the reproductive biology
48 of squid. Fertilization is internal and juveniles have no larval stage. Eggs of inshore species are often

1 enveloped in a gelatinous matrix attached to substrate, while the eggs of offshore species are extruded as
 2 drifting masses. The red armhook squid appears to spawn in the spring and to live as long as 4 years,
 3 though most die after spawning at one year to 16 months old (Arkhipkin et al. 1996). Perez (1990)
 4 estimated that squids comprise over 80 percent of the diet of some whales. Seabirds and some salmon
 5 species are also known to feed heavily on squid at certain times of the year.

6
 7 In the BSAI FMP squid are grouped in a “Squid and Other Species” group made up of squids, which are
 8 considered separately; and sculpins, skates, sharks, and octopi, which comprise the true “other species”
 9 category. Because insufficient data exists to manage each of the other species groups separately, they are
 10 considered collectively. Neither squid nor any of the species in the “other species” category are currently
 11 targeted by the groundfish fisheries in the BSAI and GOA. As such, they are only caught as bycatch by
 12 fisheries targeting groundfish. Beginning in 1999, smelts were removed from the “other species”
 13 category and have been placed, along with a wide variety of other fish and crustaceans including krill,
 14 deep-sea smelts, and lantern fishes, in the forage fish category. This action was accomplished through
 15 Amendments 36 and 39 to the BSAI and GOA groundfish FMPs. These amendments place specific catch
 16 percentage limits for forage fish on all groundfish fishery participants to prevent the development of
 17 directed forage fish fisheries. The following table presents estimated catches (mt) of other species, squid,
 18 forage fish and miscellaneous fish by groundfish fisheries in the BSAI and GOA in 1999 by target
 19 species fishery and gear using observer and NMFS blend data.

Target Groundfish Species	Gear	Other Species						Squid	Forage Fish	Miscellaneous Fish
		Skates	Sharks	Sculpins	Octopus	Total				
BSAI										
Atka mackerel	Trawl	96	0	285	0	382	5	-	75	
Pacific cod	Trawl	831	8	954	23	1,817	2	2	132	
Pacific cod	Pot	0	-	649	260	909	0	-	10	
Pacific cod	Longline	9,625	105	1,139	21	10,890	0	0	113	
Pacific cod	ALL	10,456	113	2,742	304	13,615	2	2	255	
Flatfish	Trawl	11,750	179	9,101	11	21,041	60	20	2,589	
Flatfish	Longline	5		0		5		-	42	
Flatfish	ALL	11,755	179	9,101	11	21,045	60	20	2,630	
Rockfish	Trawl	53	3	21	0	77	5	0	55	
Rockfish	Longline	9	1	0	0	11	-	-	223	
Rockfish	ALL	62	4	21	0	88	5	0	278	
Pollock	Pelagic trawl	314	104	40	0	458	403	38	209	
Pollock	Bottom trawl	42	2	18	1	62	4	1	10	
Pollock	ALL	355	105	58	1	520	406	39	219	
Rock sole	Trawl	207	0	152	12	371		0	69	
Sablefish	Pot	0			0	0		-	0	

	Target Groundfish Species	Gear	Other Species					Total	Squid	Forage Fish	Miscellaneous Fish
			Skates	Sharks	Sculpins	Octopus					
1	Sablefish	Longline	105	21	0	0	126	-	-	4,730	
2	Sablefish	ALL	105	21	0	0	126	-	-	4,730	
3	Turbot	Trawl	11		3	0	15	4	0	12	
4	Turbot	Pot	1	-	-	0	1	0	-	0	
5	Turbot	Longline	273	203	2	0	479	-	-	3,840	
6	Turbot	ALL	285	203	6	0	494	4	0	3,852	
7	Yellowfin Sole	Trawl	566	1	935	2	1,503		2	328	
8	ALL	Trawl	13,827	295	11,492	48	25,662	478	63	3,469	
9		Pot	1	-	649	260	909	0	-	10	
10		Longline	10,017	330	1,141	22	11,509	0	0	8,947	
11	ALL	ALL	23,844	625	13,282	329	38,080	478	63	12,426	

12 (continued)

	Target Groundfish Species	Gear	Other Species					Squid	Forage Fish	Miscellaneous Fish
			Skates	Sharks	Sculpins	Octopus	Total			
1	GOA									
2	Pacific cod	Trawl	216	10	98	3	238	0	15	24
3	Pacific cod	Pot	0	1	111	115	118	-	45	13
4	Pacific cod	Longline	333	230	129	5	675	-	1	5
5	Pacific cod	ALL	549	241	338	123	1,032	0	61	42
6	Flatfish	Trawl	470	46	58	9	490	7	9	350
7	Flatfish	Longline	0	-	-	-	-	-	-	4
8	Flatfish	ALL	470	46	58	9	490	7	9	353
9	Rockfish	Trawl	46	5	26	0	17	6	101	123
10	Rockfish	Longline	27	58	0	-	-	-	10	6
11	Rockfish	ALL	73	63	26	0	17	6	111	129
12	Pollock	Bottom Trawl	20	63	0	0	83	2	2	107
13	Pollock	Pelagic trawl	2	131	3	0	118	18	23	120
14	Pollock	ALL	22	194	4	0	201	20	25	227
15	Sablefish	Trawl	0	-	0	0	-	0	0	1
16	Sablefish	Longline	200	126	0	0	19	1	2	9,338
17	Sablefish	ALL	201	126	0	0	19	1	2	9,339
18	ALL	Trawl	754	255	185	13	946	33	151	724
19	ALL	Pot	0	1	111	115	118	-	45	13
20	ALL	Longline	1,030	460	187	15	1,184	8	22	9,703
21	ALL	ALL	1,784	716	484	143	2,248	41	218	10,440

22
23 Note: Forage fish are myctophids, osmerids, bathylagids, sandfish, sand lance, gunnels, and
24 pricklebacks. Miscellaneous fish are mostly grenadiers, but also include greenlings, poachers,
25 lumpsuckers, ronquils, gastropods, fish waste, snipe eels, eelpouts, hagfish, pomfrets, and
26 snailfish. "-": < 0.01 mt; "0": > 0.01 and <0.5 mt of estimated catch.
27
28

29 Assessment data are not available for squid from AFSC surveys because of their mainly pelagic
30 distribution over deep water. Information on the distribution, abundance, and biology of squid stocks in
31 the EBS and Aleutian Islands region is generally lacking. Red armhook squid predominates in
32 commercial catches in the EBS and GOA, and *Onychoteuthis boreali japonicus* is the principal species
33 encountered in the Aleutian Islands region.
34

35 Forty-one species of sculpins were identified in the EBS and 22 species in the Aleutian Islands region
36 (Bakkala 1993, Bakkala et al. 1985, Ronholt et al. 1985). During these same surveys, 15 species of skates
37 were identified but inadequate taxonomic keys for this family may have resulted in more species being

1 identified than actually exist. Species that have been consistently identified during surveys are the Alaska
2 skate, big skate, longnose skate, starry skate, and Aleutian skate. Biomass estimates of sculpins and
3 skates from demersal trawl surveys serve as valuable indices of their relative abundance.
4

5 While biomass estimates have been made for sharks and octopi, the AFSC bottom trawl surveys are not
6 designed to adequately sample the realms they inhabit. Sharks are rarely taken during demersal trawl
7 surveys in the Bering Sea; however, spiny dogfish is the species usually caught, and the Pacific sleeper
8 shark has been taken on occasion. Two species of octopus have been recorded, with *Octopus dofleini*, the
9 principal species, and *Opisthoteuthis californica* appearing only intermittently.
10

11 Many species in the squid and other species assemblage are important as prey for marine mammals and
12 birds as well as commercial groundfish species. Squid and octopus are consumed primarily by marine
13 mammals, such as Steller sea lions ((Lowry et al. 1982), northern fur seals (Perez and Bigg 1986), harbor
14 seals (Lowry et al. 1982, Pitcher 1980b), sperm whales (Kawakami 1980), Dall's porpoise (Crawford
15 1981), and Pacific white-sided dolphins (Morris et al. 1983), and beaked whales (Loughlin and Perez
16 1985)). Sculpins have also been found in the diet of harbor seals (Lowry et al. 1982).
17

18 *EBS and GOA Biomass Estimates for Squid and Other Species*

19

20 Data from AFSC surveys provide the only abundance estimates for the various groups and species
21 comprising the "other species" category. Biomass estimates for the EBS are from a standard survey area
22 of the continental shelf. The 1979, 1981, 1982, 1985, 1988 and 1991 data include estimates from
23 continental slope waters (200-1,000 m in 1979, 1981, 1982, and 1985; 200-800 m in 1988 and 1991), but
24 data from other years do not. Slope estimates were usually 5 percent or less of the shelf estimates, except
25 for grenadiers. Stations as deep as 900 m were sampled in the 1980, 1983 and 1986 Aleutian Islands
26 bottom trawl surveys, while surveys in 1991 and 1994 obtained samples only to a depth of 500 m.
27

28 Since the survey biomass estimates for species other than squid vary substantially from year to year due
29 to different distributions of the component species, it is probably more reliable to estimate current
30 biomass by averaging estimates of recent surveys. The average biomass of other species from the last
31 three EBS surveys (1997-99) is 561,600 mt; adding the estimate from the 1997 Aleutian Islands survey
32 (48,800 mt) yields a total BSAI "other species" biomass estimate of 610,400 mt.
33

34 Biomass estimates from AFSC surveys illustrate that sculpins were the major component of this group
35 until 1986, after which the biomass of skates exceeded that of sculpins. The abundance of skates
36 increased between 1985 and 1990 (when a high of 583,800 mt survey biomass was observed), but has
37 since declined to about 370,000 mt in 1999. The abundance of sculpins remained relatively stable
38 through 1998, but declined to the lowest biomass estimate since 1975 in 1999.
39

40 Trends in the biomass of GOA "other species" (sharks, skates, sculpins, smelts, octopi, and squids) were
41 investigated using the NMFS triennial trawl survey data from 1984 through 1999. Any discussion of
42 biomass trends should be viewed with the following caveats in mind: 1) Survey efficiency may have
43 increased for a variety of reasons between 1984 and 1990, but should be stable after 1990 (Robin
44 Harrison, personal communication). 2) Surveys in 1984, 1987, and 1999 included deeper strata than the
45 1990 - 1996 surveys. Therefore, the biomass estimates for deeper-dwelling components of the other
46 species category are not comparable across all years.
47

48 The average biomass within the other species category using all six(6) survey biomass estimates is

1 160,000 tons. The most recent estimate of other species biomass (1999) is 213,000 tons. Skates represent
2 30-40 percent of the other species biomass from all surveys and are the most common group in each year
3 except 1984, when sculpin biomass was highest within the category. Total biomass for the other species
4 category has increased between 1984 and 1999. This is the result of apparent increases in skate, shark,
5 and smelt biomass, some of which may be difficult to resolve from changes in survey efficiency. Sculpin
6 biomass appears relatively stable over this period.

7
8 Individual species biomass trends were evaluated for the more common and easily identified shark and
9 sculpin species encountered by the triennial trawl survey. In general, the increasing biomass trend for the
10 shark species group is as result of increases in spiny dogfish and sleeper shark biomass between 1990 and
11 1999. Salmon shark biomass has been stable to decreasing, according to this survey, but salmon sharks
12 are unlikely to be well sampled by a bottom trawl (as evidenced by the high uncertainty in the biomass
13 estimates). It should be noted that both salmon shark and Pacific sleeper shark biomass estimates may be
14 based on a very small number of individual tows in a given survey. No salmon sharks were encountered
15 in the 1999 survey, despite reports of their increased abundance in other areas of the GOA.

16
17 Individual sculpin species display divergent biomass trends between 1984 – 1999. While the biomass of
18 bigmouth sculpins has decreased over the period of the survey, great sculpin biomass has remained
19 relatively stable, and yellow Irish lord biomass has increased. The biomass of yellow Irish lords appears
20 to have increased over time despite general stability in the number of hauls where they occurred, whereas
21 bigmouth sculpins were encountered in fewer hauls each year. Uncertainty in these estimates varies
22 between years.

23
24 In addition to sharks and sculpins, we examined available biomass estimates for grenadiers, which are
25 not included in the other species category. The species most commonly encountered in the triennial trawl
26 surveys was the giant grenadier. The Pacific grenadier was present, but with much lower estimated
27 biomass in all years. Survey coverage of deeper strata is particularly important to grenadier biomass
28 estimates; therefore we consider the 1990–1996 survey estimates to be of little use for detecting trends in
29 grenadier abundance

30 *Current Stock Assessment and OFL/ABC/TAC Determinations*

31
32
33 No reliable biomass estimates for squid exist, and no stock assessment per se. Sobolevsky (1996) cites an
34 estimate of four million tons for the entire Bering Sea made by squid biologists at TINRO (Shuntov et al.
35 1993), and an estimate of 2.3 million tons for the western and central Bering Sea (Radchenko 1992), but
36 admits that squid stock abundance estimates have received little attention. AFSC bottom trawl surveys
37 almost certainly underestimate squid abundance. Squid catches and ABCs are almost certainly a very
38 small percentage of the total squid biomass in the EBS and GOA. BSAI squid ABC and OFL are set
39 using criteria in Tier 6 as described in Amendment 44 to the BSAI FMP given the lack of data on their
40 population dynamics and biomass. OFL is set equal to the average annual catch from 1978 to 1995 (2,624
41 mt), while ABC is capped at no greater than 75 percent of OFL (1,970 mt). As currently defined, BSAI
42 squid ABC and OFL values would remain constant in the future, unless different methodologies were
43 employed to assess squid abundance (e.g., analysis of fishery CPUE data). This methodology change
44 could occur under any of the alternatives considered. The BSAI squid TAC has been set equal to the
45 stock-assessment-recommended ABC by the Council.

46
47 Reliable biomass estimates exist for two (skates and sculpins) of the groups that comprise the bulk of the
48 biomass and fishery catches in the other species category. Survey biomass estimates for sharks, smelts,

1 and octopi, while not reliable, represent the best data available on the abundance of these species. A
2 single estimate of M for this diverse assemblage, while not known, is conservatively estimated at 0.2.
3 OFL for the other species assemblage is set using the criteria in Tier 5 as described in Amendment 44,
4 where $F_{OFL}=M$, and $OFL=M \times$ (total other species survey biomass). Using Tier 5 criteria, ABC is capped
5 at 75 percent of OFL. However, rather than use this method, the other species ABC has been calculated
6 as the average annual catch since 1978 to avoid potentially 5-fold increases in other species catches that
7 could occur if it were set at 75 percent of OFL. In 1998 (for the 1999 fishery), the Council began a 10-
8 step increase toward full $F=M$ exploitation strategy for “other species” complex by implementing the
9 first 10 percent of the difference between that strategy and average catch since 1978. For the 2000
10 fishery, the Council stopped the step-wise increase and kept the ABC at a level approximately 10 percent
11 higher than the stock assessment author’s recommendation. BSAI area other species TAC has been set
12 equal to the other species ABC by the Council. A 2000 ABC for the BSAI other species category set
13 using this process (31,360 mt) represents an exploitation rate of about 5 percent of the best estimate of
14 current biomass (610,400 mt). This estimate was obtained by averaging the three most recent EBS
15 bottom trawl survey estimates of other species biomass (from 1997 to 1999: 561,600 mt), and adding the
16 most recent Aleutian Islands bottom trawl estimate (from 1997: 48,800 mt).

17
18 The annual TAC for other species in the GOA (which includes squid) is set equal to 5 percent of the sum
19 of all GOA groundfish TACs. Catches of other species in the GOA have ranged between 1,570 and 6,867
20 mt from 1990 to 1999.

1 **Literature cited**

- 2
- 3 Albers, W.D., and P.J. Anderson. 1985. Diet of Pacific cod, *Gadus macrocephalus*, and predation on the
4 northern pink shrimp, *Pandalus borealis*, in Pavlov Bay, Alaska. Fish. Bull. 83:601-610.
- 5 Alderdice, D.F., and C.R. Forrester. 1968. Some effects of salinity and temperature on early
6 development and survival of the English sole (*Parophrys vetulus*). J. Fish. Res. Board Canada
7 25:495-521.
- 8 Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and
9 northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 66, 151 pp.
- 10 Alton, M.S., R.G. Bakkala, G.E. Walters, and P.T. Munro. 1988. Greenland turbot, *Rheinhardtius*
11 *hippoglossoides*, of the Eastern Bering Sea and Aleutian Islands. U.S. Dep. Commer., NOAA
12 Tech. Rep. NMFS 71, 31 pp.
- 13 Alton, M.S., and B.A. Megrey. 1986. Condition of the walleye pollock resource of the Gulf of Alaska as
14 estimated in 1985. U.S. Dep. of Commer., NOAA Tech. Memo. NMFS F/NWC-106.
- 15 Archibald, C.P., W. Shaw, and B.M. Leaman. 1981. Growth and mortality estimates of rockfishes
16 (Scorpaenidae) from B.C. coastal waters, 1977-79. Canadian Tech. Rep. of Fish. Aquat. Sci.
17 1048:57.
- 18 Arkhipkin, A.I., V.A. Bizikov, V.V. Krylov, and K.N. Nesis. 1996. Distribution, stock structure, and
19 growth of the squid *Berryteuthis magister* (Berry, 1913) (Cephalopoda Gonatidae) during
20 summer and fall in the western Bering Sea. Fish. Bull. 94:1-30.
- 21 Bailey, K.M. 1989. Interaction between the vertical distribution of juvenile walleye pollock *Theragra*
22 *chalcogramma* in the eastern Bering Sea, and cannibalism. Mar. Ecol. Prog. Ser. 53:205-213.
- 23 Bailey, K.M., R.D. Brodeur, and A.B. Hollowed. 1996. Cohort survival patterns of walleye pollock,
24 *Theragra chalcogramma*, in Shelikof Strait, Alaska: a critical factor analysis. Fish. Oceanogr.
25 5: 179-188.
- 26 Bailey, K.M., and S.A. Macklin. 1994. Analysis of patterns in larval walleye pollock (*Theragra*
27 *chalcogramma*) survival and wind mixing events in Shelikof Strait, Gulf of Alaska. Mar. Fish.
28 Ecol. Prog. Ser. 113:1-12.
- 29 Bakkala, R.G. 1984. Pacific cod of the eastern Bering Sea. Internatl. N. Pac. Fish. Comm. Bull.
30 42:157-179.
- 31 Bakkala, R.G. 1993. Structure and historical changes in the groundfish complex of the eastern Bering
32 Sea. NOAA Tech. Rep. NMFS 114, 91 pp.
- 33 Bakkala, R.G., J. Traynor, K. Teshima, A.M. Shimada, and H. Yamaguchi. 1985. Results of cooperative
34 U.S.-Japan groundfish investigations in the eastern Bering Sea during June-November 1982.
35 U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-87, 448 pp.
- 36 Best, E.A., and F. St-Pierre. 1986. Pacific halibut as predator and prey. Int. Pac. Halibut Comm., P.O.
37 Box 95009, Seattle, WA 98145. Technical Report 21.
- 38 Bograd, S.J., P.J. Stabeno, and J.D. Schumacher. 1994. A census of mesoscale eddies in Shelikof Strait,
39 Alaska, during 1991. Geophys. Res. 99:18243-18254.
- 40 Brodeur, R.D., and Percy, W.G. 1984. Food habits and dietary overlap of some shelf rockfishes (genus
41 *Sebastes*) from the northeastern Pacific Ocean. Fishery Bulletin 82:269-294.
- 42 Brodeur, R.D., and C.T. Wilson. 1996. A review of the distribution, ecology, and population dynamics
43 of age-0 walleye pollock in the Gulf of Alaska. Fish. Oceanogr. 5:148-166.
- 44 Buckland, S.T., D.R. Anderson, K.P. Burnham, and J.L. Laake. 1993. Distance Sampling: Estimating
45 abundance of biological populations. Chapman & Hall, London, England, 446 pp.
- 46 Bulatov, O.A. 1983. Distribution of eggs and larvae of Greenland halibut, *Reinhardtius hippoglossoides*
47 (Pleuronectidae) in the eastern Bering Sea. J. Ichthyol. 23:157-159.
- 48 Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimation of density from line transect sampling

- 1 of biological populations. Wildl. Monogr. 72:202.
- 2 Byrd, G.V., J.C. Williams, and R. Walder. 1992. Status and biology of the tufted puffin in the Aleutian
3 Islands, Alaska after a ban on salmon driftnets. U. S. Fish and Wildlife Service, Alaska
4 Maritime National Wildlife Refuge, Aleutian Islands Unit, PSC 486, Box 5251, FPO AP
5 96506-5251, Adak Alaska.
- 6 Calkins, D.G. 1987. Marine Mammals. In The Gulf of Alaska: physical environment and biological
7 resources. D. W. Hood, S. T. Zimmerman (eds.), pp. 527-560. Alaska Office, Ocean
8 Assessments Division, National Oceanic and Atmospheric Administration, U.S. Dep. of
9 Commer., and the Alaska OCS Region Office, Minerals Management Service, U.S. Department
10 of the Interior. Washington, DC.
- 11 Canino, M.F. 1994. Effects of temperature and food availability on growth and RNA/DNA ratios of
12 walleye pollock, *Theragra chalcogramma* (Pallas), eggs and larvae. J. Exp. Mar. Biol. Ecol.
13 175:1-16.
- 14 Carlson, H.R. 1995. Consistent yearly appearance of age-0 walleye pollock, *Theragra chalcogramma*, at
15 a coastal site in southeastern Alaska, 1973-1994. Fish. Bull. 93:386-390.
- 16 Carlson, H.R., and R.R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in
17 rocky coastal areas of Southeastern Alaska. Marine Fisheries Review. 43:13-19.
- 18 Chilton, D.E., and R.J. Beamish. 1982. Age determination methods for fishes studied by the Groundfish
19 Program at the Pacific Biological Station. Canada Spec. Pub. Fish. Aquat. Sci. 60:102.
- 20 Clausen, D.M. 1983. Food of walleye pollock, *Theragra chalcogramma*, in an embayment of
21 southeastern Alaska. Fish. Bull. 81:637-642.
- 22 Clausen, D.M., and J. Heifetz. 1999. Pelagic shelf rockfish. In Stock Assessment and Fishery
23 Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska Plan
24 Team, pp. 405-426. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite
25 306, Anchorage, AK 99501)
- 26 Crawford, T.W. 1981. Ph.D. University of Michigan, Ann Arbor, MI.
- 27 Decker, M.B., G.L. Hunt, Jr., and G.V. Byrd, Jr. 1995. The relationships among sea-surface
28 temperature, the abundance of juvenile walleye pollock (*Theragra chalcogramma*), and the
29 reproductive performance and diets of seabirds at the Pribilof Islands, southeastern Bering
30 Sea. Pp. 425-437 in R.J. Beamish (ed.), Climate change and northern fish populations. Can.
31 Spec. Publ. Fish. Aquat. Sci. 121.
- 32 DeGange, A.R., and G.A. Sanger. 1986. Marine Birds. Pp. 479-524 in The Gulf of Alaska: Physical
33 environment and biological resources. D. W. Hood, S. T. Zimmerman (eds.), U.S. National
34 Oceanic and Atmospheric Administration, Ocean Assessments Division, Anchorage, Alaska.
- 35 de Groot, S.J. 1970. Some notes on the ambivalent behavior of the Greenland halibut, *Reinhardtius*
36 *hippoglossoides* (Walb.) Pisces: Pleuronectiformes. J. Fish. Biol. 2:275-279.
- 37 Dorn, M.W., A. B. Hollowed, E. Brown, B. Megrey, C. Wilson, and J. Blackburn. 1999. Walleye
38 pollock. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of
39 the Gulf of Alaska. Gulf of Alaska Plan Team, pp. 35-104. (North Pacific Fishery
40 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 41 Dwyer, D.A. 1984. M.S. thesis. University of Washington. 102 pp.
- 42 Dwyer, D.A., Bailey, K. M., and Livingston, P. A. 1987. Feeding habits and daily ration of walleye
43 pollock (*Theragra chalcogramma*) in the eastern Bering Sea, with special reference to
44 cannibalism. Can. J. Fish. Aquat. Sci. 44:1972-1984.
- 45 D'yakov, Y.P. 1982. The fecundity of the Greenland halibut *Reinhardtius hippoglossoides*
46 (Pleuronectidae), from the Bering Sea. J. Ichthyol. 22:59-64.
- 47 Eschmeyer, W.N., E.S. Herald, H. Hammann, and K.P. Smith. 1984. A field guide to Pacific coast
48 fishes of North America from the Gulf of Alaska to Baja California. Houghton-Mifflin,

- 1 Boston, 336 pp.
- 2 Forrester, C.R. 1964. Demersal quality of fertilized eggs of rock sole (*Lepidopsetta bilineata* Ayres). J.
3 Fish. Res. Board Canada 21:1531-1532.
- 4 Fritz, L.W., R.C. Ferrero, and R.J. Berg. 1995. The threatened status of Steller sea lions, *Eumetopias*
5 *jubatus*, under the Endangered Species Act: Effects on Alaska Groundfish Fisheries
6 Management. Mar. Fish. Rev. 57:14-27.
- 7 Grant, W.S., C.I. Zhang, T. Kobayashi, and G. Stahl. 1987. Lack of genetic stock discretion in Pacific
8 cod (*Gadus macrocephalus*). Canadian J. Fish. Aquat. Sci. 44:490-498.
- 9 Greene, D.H., and J.K. Babbitt. 1990. Control of muscle softening and protease-parasite interactions in
10 arrowtooth flounder, *Atheresthes stomias*. Journal of Food Science 55:579-580.
- 11 Grover, J. J. 1990. Feeding ecology of late-larval and early juvenile walleye pollock (*Theragra*
12 *chalcogramma*) from the Gulf of Alaska in 1987. Fish. Bull. 88:463-470.
- 13 Hagerman, F.B. 1952. The biology of the dover sole, *Microstomus pacificus* (Lockington). Calif. Div.
14 Fish Game Fish. Bull. 78:64.
- 15 Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada Bull. 180, Canadian Government
16 Publishing Centre, Supply and Services Canada, Ottawa, K1A 0S9, 740 pp.
- 17 Hatch, S.A., and G.A. Sanger. 1992. Puffins as samplers of juvenile pollock and other forage fish in the
18 Gulf of Alaska. Mar. Ecol. Prog. Ser. 80:1-14.
- 19 Heifetz, J., and D. Ackley. 1997. Bycatch in rockfish fisheries in the Gulf of Alaska. National Marine
20 Fisheries Service, Auke Bay Laboratory, 11305 Glacier Hwy, Juneau, AK 99801, unpubl.
21 manuscr., 17 pp.
- 22 Heifetz, J., and D.M. Clausen. 1991. Slope rockfish. Pp. 362-396 in Stock Assessment and Fishery
23 Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska Plan
24 Team (eds.), North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
25 Anchorage, AK 99501.
- 26 Heifetz, J., and J.T. Fujioka. 1991. Movement dynamics of tagged sablefish in the northeastern Pacific
27 Ocean. Fisheries Research, 11:344-374.
- 28 Heifetz, J., J.N. Ianelli, and D.M. Clausen. 1997. Slope rockfish. Pp. 248-289 in Stock Assessment and
29 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for
30 1998. Gulf of Alaska Plan Team (eds.), North Pacific Fishery Management Council, 605 W.
31 4th Avenue, Suite 306, Anchorage, AK 99501.
- 32 Heifetz, J., J.N. Ianelli, D.M. Clausen, and J. T. Fujioka. 1999. Slope rockfish. In Stock Assessment and
33 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska
34 Plan Team, pp. 307-404. (North Pacific Fishery Management Council, 605 W. 4th Avenue,
35 Suite 306, Anchorage, AK 99501).
- 36 Hermann, A.J., S. Hinckley, B.A. Megrey, and P.J. Stabeno. 1996. Interannual variability of the early
37 life history of walleye pollock near Shelikof Strait as inferred from a spatially explicit,
38 individual - based model. Fish. Oceanogr. 5:39-57.
- 39 Hirschberger, W.A., and G.B. Smith. 1983. Spawning of twelve groundfish species in the Alaska and
40 Pacific coast regions, 1975-1981. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-
41 44, 50 pp.
- 42 Hollowed, A. B., E. Brown, J. Ianelli, P. Livingston, B. Megrey, and C. Wilson. 1997. Walleye pollock.
43 North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK
44 99501, pp. 362-396.
- 45 Hollowed, A.B., B.A. Megrey, P. Munro, and W. Karp. 1991. Walleye pollock. In Stock Assessment
46 and Fishery Evaluation Report for the 1992 Gulf of Alaska Groundfish Fishery. Gulf of
47 Alaska Plan Team, Ed North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite
48 306, Anchorage, AK 99501.

- 1 Hollowed, A.B., and W.S. Wooster. 1995. Decadal-scale variations in the eastern Subarctic Pacific: II.
2 Response of Northeast Pacific fish stocks. In *Climate Change and Northern Fish Populations*.
3 *Can. Spec. Pub. of the Fish. Aquat. Sci.* 121:373-385.
- 4 Honkalehto, T. 1989. A length-cohort analysis of walleye pollock based on empirical estimation of
5 cannibalism and predation by marine mammals. *Proceedings Intl. Symp. Biol. Management*
6 *Walleye Pollock*, November 1988. University of Alaska, Fairbanks, AK 99775. Alaska Sea
7 Grant Report 89-1. pp. 651-665.
- 8 Hubbs, C.L., and N.J. Wilimovsky. 1964. Distribution and synonymy in the Pacific Ocean and variation
9 of the Greenland halibut, *Rheinhardtius hippoglossoides* (Walbaum). *J. Fish. Res. Board*
10 *Canada*. 21:1129-1154.
- 11 Hunt, G.L. Jr., B. Burgeson, and G.A. Sanger. 1981. Feeding ecology of seabirds of the eastern Bering
12 Sea. Pp. 629-647 in *The Eastern Bering Sea Shelf: Oceanography and Resources*. D. W.
13 Hood, J. A. Calder (eds.), University of Washington Press. Seattle, WA, vol. 2.
- 14 Hunt, G.L. Jr., M.B. Decker, and A. Kitaysky. 1995. Fluctuations in the Bering Sea ecosystem as
15 reflected in the reproductive ecology and diets of kittiwakes on the Pribilof Islands, 1975 to
16 1990. in *Aquatic Predators and their Prey*. S. P. R. Greenstreet, M. L. Tasker (eds.),
17 Blackwell Scientific Publications, Oxford.
- 18 Ianelli, J.N., L. Fritz, T. Honkalehto, N. Williamson, and G. Walters. 1999. Eastern Bering Sea walleye
19 pollock assessment. In *Stock Assessment and Fishery Evaluation Report for the Groundfish*
20 *Resources of the Bering Sea/Aleutian Islands Region*. Bering Sea/Aleutian Islands Plan Team,
21 pp. 37-150. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
22 Anchorage, AK 99501)
- 23 Ianelli, J.N., and S. Gaichas. 1999. Stock assessment of Gulf of Alaska thornyheads (*Sebastolobus sp.*).
24 In *Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf*
25 *of Alaska*. Gulf of Alaska Plan Team, pp. 467-510. (North Pacific Fishery Management
26 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 27 Ianelli, J.N., and T.M. Wilderbuer. 1995. Greenland turbot (*Reinhardtius hippoglossoides*) stock
28 assessment and management in the Eastern Bering Sea. in *Proceedings of the International*
29 *Symposium on North Pacific Flatfish*, Alaska Sea Grant Report AK-SG-95-04, University of
30 Alaska, Fairbanks, Fairbanks, AK 99775. pp. 407-441.
- 31 Ianelli, J.N., T.K. Wilderbuer, and T.M. Sample. 1997. Stock assessment of Greenland Turbot. in *Stock*
32 *Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering*
33 *Sea/Aleutian Islands Regions*. Bering Sea/Aleutian Islands Plan Team (eds.), North Pacific
34 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501, pp. 188-
35 218.
- 36 Ito, D.H., and P.D. Spencer. 1999. Other rockfish. In *Stock Assessment and Fishery Evaluation Report*
37 *for the Groundfish Resources of the Bering Sea/Aleutian Islands Region*. Bering Sea/Aleutian
38 Islands Plan Team, pp. 559-568. (North Pacific Fishery Management Council, 605 W. 4th
39 Avenue, Suite 306, Anchorage, AK 99501)
- 40 Ito, D.H., P.D. Spencer, and J.N. Ianelli. 1999. Pacific Ocean Perch. In *Stock Assessment and Fishery*
41 *Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region*.
42 Bering Sea/Aleutian Islands Plan Team, pp. 519-558. (North Pacific Fishery Management
43 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501).
- 44 Jewett, S.C. 1978. Summer food of the Pacific cod, *Gadus macrocephalus*, near Kodiak Island, Alaska.
45 *Fish. Bull.* 76:700-706.
- 46 Kajimura, H., and C.W. Fowler. 1984. Apex predators in the walleye pollock ecosystem in the eastern
47 Bering Sea and Aleutian Islands regions. Pp. 193-234 in *Proceedings of the workshop on*
48 *walleye pollock and its ecosystem in the eastern Bering Sea*, D. H. Ito (ed.). U.S. Dep.

- 1 Commer., NOAA Tech. Memo. NMFS F/NWC-62.
- 2 Kawakami, T. 1980. A review of sperm whale food. Scientific Report of the Whales Research Institute
3 Tokyo 32:199-218.
- 4 Kendall, A.W.J., M.E. Clarke, M.M. Yoklavich, and G.W. Boehlert. 1987. Distribution, feeding and
5 growth of larval walleye pollock, *Theragra chalcogramma*, from Shelikof Strait, Gulf of
6 Alaska. Fish. Bull. 85:499-521.
- 7 Kendall, A.W., and W.H. Lenarz. 1986. Status of early life history studies of northeast Pacific
8 rockfishes. Proc. of the Internatl. Rockfish Symp., Anchorage, AK, pp. 99-117.
- 9 Kendall, A.W., Schumacher, J.D., and Kim, S. 1996. Walleye pollock recruitment in Shelikof Strait:
10 Applied fisheries oceanography. Fish. Oceanogr. 5:4-18.
- 11 Ketchen, K.S. 1964. Preliminary results of studies on a growth and mortality of Pacific cod (*Gadus*
12 *macrocephalus*) in Hecate Strait, British Columbia. J. Fish. Res. Board Canada 21:1051-1067.
- 13 Kimura, D.K. and L.L. Ronholt. 1988. Atka mackerel. Pp. 147-171 in R. Bakkala (ed.), Condition of
14 groundfish resources of the eastern Bering Sea and Aleutian Islands region in 1987. U.S. Dep.
15 Commer., NOAA Tech. Memo. NMFS F/NWC-139.
- 16 Knechtel, C.D., and L.J. Bledsoe. 1981. A numerical simulation model of the population dynamics of
17 walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem. Part I,
18 Model Description, in U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-19.
- 19 Knechtel, C.D., and L.J. Bledsoe. 1983. A numerical simulation model of the population dynamics of
20 walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem: Part II,
21 Model calibration, validation, and exercise. U.S. Dep. of Commer., NOAA Tech. Memo.
22 NMFS F/NWC-50. 264 pp. investigations in Alaska, 1996-1997. Alaska Department of Fish
23 and Game Contract Report: 125 pp.
- 24 Kramer, D.E., and V.M. O'Connell, V. M. 1988. Guide to Northeast Pacific Rockfishes: Genera
25 *Sebastes* and *Sebastobus*. Alaska Sea Grant Advisory Bulletin 25.
- 26 Krieger, K.J. 1985. Food habits and distribution of first-year walleye pollock, *Theragra chalcogramma*
27 (Pallas), in Auke Bay, Southeastern Alaska. M.S. Thesis. University of Alaska Southeast,
28 11120 Glacier Highway, Juneau, AK 99801. 57 pp.
- 29 Krieger, K.J. 1993. Distribution and abundance of rockfish determined from a submersible and by
30 bottom trawling. Fishery Bulletin. 91:87-96.
- 31 Krieger, K.J. 1997. Sablefish, *Anoplopoma fimbria*, observed from a manned submersible. in Biology
32 and Management of Sablefish, *Anoplopoma fimbria*, M. E. Wilkins, M. W. Saunders, Eds.,
33 NOAA Technical Report NMFS 130 U.S. Department of Commerce, NOAA.
- 34 Kreiger, K.J., and D.H. Ito. 1999. Distribution and abundance of shorttraker rockfish, *Sebastes borealis*,
35 and rougheye rockfish, *S. aleutianus*, determined from a manned submersible. Fish. Bull.
36 97:264-272.
- 37 Laevastu, T., and H.A. Larkins. 1981. Marine fisheries ecosystem, its quantitative evaluation and
38 management. Fishing News Books Ltd., Farnham, Surrey, England.
- 39 Laidig, T.E., P.B. Adams, and W.M. Samiere. 1997. Feeding habits of sablefish, *Anoplopoma fimbria*,
40 off the coast of Oregon and California. in Biology and Management of Sablefish,
41 *Anoplopoma fimbria*, M. E. Wilkins, M. W. Saunders (eds.). U.S. Dep. Commer., NOAA
42 Tech. Rep. NMFS 130.
- 43 Lang, G.M., and P.A. Livingston. 1996. Food habits of key groundfish species in the eastern Bering Sea
44 slope region. U.S. Dep. of Commer., NOAA Tech. Mem. NMFS-AFSC-297. 110 pp.
- 45 Levings, C.S.M. 1968. Fertilized eggs of the butter sole, *Isopsetta isolepis*, in Skidegate Inlet, British
46 Columbia. J. Fish. Res. Board Canada. 25:1743-1744.
- 47 Livingston, P.A. 1985. Summer food habits of young-of-the-year walleye pollock, *Theragra*
48 *chalcogramma*, in the Kodiak area of the Gulf of Alaska during 1985. AFSC, 7600 Sand Point

- 1 Way NE, Seattle, WA 98115. Unpubl. manusc.
- 2 Livingston, P.A. 1989a. Key fish species, northern fur seals (*Callorhinus ursinus*), and fisheries
3 interactions involving walleye pollock (*Theragra chalcogramma*), in the eastern Bering Sea. J.
4 Fish. Biol. 35:179-186.
- 5 Livingston, P.A. 1989b. Interannual trends in walleye pollock, *Theragra chalcogramma*, cannibalism in
6 the eastern Bering Sea. Pp 275-296 in Proceedings of the International Symposium Biol.
7 Management Walleye Pollock, November 1988. Alaska Sea Grant Report 89-1.
- 8 Livingston, P.A. 1991a. Total groundfish consumption of commercially important prey. U.S. Dep.
9 Commer., NOAA Tech. Memo. NMFS F/NWC-207. 240 pp.
- 10 Livingston, P.A. 1991b. Groundfish food habits and predation on commercially important prey species
11 in the Eastern Bering Sea from 1984-1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS
12 F/NWC-207. 240 pp.
- 13 Livingston, P.A. 1993. Importance of predation by groundfish, marine mammals and birds on walleye
14 pollock and Pacific herring in the eastern Bering Sea. Marine Ecology Prog. Ser. 102:205-215.
- 15 Livingston, P.A. 1994. Overview of multispecies interactions involving walleye pollock in the eastern
16 Bering Sea and Gulf of Alaska. Draft manusc.
- 17 Livingston, P.A., and Y. DeReynier. 1996. Groundfish food habits and predation on commercially
18 important prey species in the eastern Bering Sea from 1990 to 1992. AFSC Processed Report
19 96-04. 214 pp.
- 20 Livingston, P.A., D.A. Dwyer, D.L. Wencker, M.S. Yang, and G.M. Yang. 1986. Trophic interactions of
21 key fish species in the eastern Bering Sea. Symposium on biological interactions in the North
22 Pacific region and on factors affecting recruitment, distribution, and abundance of non-
23 anadromous species. International North Pacific Fisheries Commission. INPFC Bull. 47:49-
24 65.
- 25 Livingston, P.A., and G.M. Lang. 1997. Interdecadal comparisons of walleye pollock cannibalism in the
26 eastern Bering Sea. in Ecology of Juvenile Walleye Pollock. R.D. Brodeur, P.A. Livingston,
27 A. Hallowed, T. Loughlin (eds.), pp. 115-124. U.S. Dep. Commer., NOAA.
- 28 Livingston, P.A., A. Ward, G.M. Lang, and M.S. Yang. 1993. Groundfish food habits and predation on
29 commercially important prey species in the eastern Bering Sea from 1987 to 1989. U.S. Dep.
30 Commer., NOAA Tech. Memo. NMFS-AFSC-11, 192 pp.
- 31 Loughlin, T.R., and M.A. Perez. 1985. *Mesoplodon stejnegeri*. Mammalian Species. 250.
- 32 Lowe, S.A., and L.W. Fritz. 1996. Atka mackerel. In Stock assessment and fishery evaluation report for
33 the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery
34 Management Council. 605 West 4th Ave., Suite 306, Anchorage, Alaska 99510.
- 35 Lowe, S.A., and L.W. Fritz. 1997. Atka mackerel. In Stock assessment and fishery evaluation report for
36 groundfish resources in the Bering Sea/Aleutian Islands Region as projected for 1998. North
37 Pacific Fishery Management Council. 605 W. 4th Ave., Suite 306, Anchorage, AK.
- 38 Lowe, S.A., and L.W. Fritz. 1999a. Assessment of Bering Sea/Aleutian Islands Atka mackerel. In Stock
39 Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering
40 Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team, pp. 569-638. (North
41 Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 42 Lowe, S.A., and L.W. Fritz. 1999b. Assessment of Gulf of Alaska Atka mackerel. In Stock Assessment
43 and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of
44 Alaska Plan Team, pp. 511-536. (North Pacific Fishery Management Council, 605 W. 4th
45 Avenue, Suite 306, Anchorage, AK 99501)
- 46 Lowe, S.A., D.M. Van Doornik, and G.A. Winans. 1998. Geographic variation in genetic and growth
47 patterns of Atka mackerel, *Pleurogrammus monopterygius* (Hexagrammidae), in the Aleutian
48 archipelago. Fish. Bull. U.S. 96:502-515.

- 1 Lowry, L.F., V.N. Burkanov, and K.J. Frost. 1997. Importance of walleye pollock in the diet of phocid
2 seals in the Bering Sea and northwestern Pacific Ocean. U.S. Dep. Commer., NOAA Tech.0
3 Rep. 126.
- 4 Lowry, L.F., K.J. Frost, D.G. Calkins, G.L. Swartzman, and S. Hills. 1982. Feeding habits, food
5 requirements, and status of Bering Sea marine mammals. Final report to the North Pacific
6 Fishery Management Council, P.O. Box 3136 DT, Anchorage, Alaska 99510. Contract No.
7 81-4.
- 8 Lowry, L.F., K.J. Frost, and T.R. Loughlin. 1989. Importance of walleye pollock in the diets of marine
9 mammals in the Gulf of Alaska and Bering Sea, and implications for fishery management.
10 Alaska Sea Grant Report AK-SG-89-01. Pp. 701-726.
- 11 Maloney, N.E., and J. Heifetz. 1997. Movements of tagged sablefish, *Anoplopoma fimbria*, released in
12 the eastern Gulf of Alaska. In *Biology and Management of Sablefish, Anoplopoma fimbria*,
13 M. E. Wilkins, M. W. Saunders (eds.). U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
- 14 Martin, M.H., and D.M. Clausen. 1995. Data report: 1993 Gulf of Alaska bottom trawl survey. U.S.
15 Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-59, 217 pp.
- 16 McDermott, S.F. 1994. Masters. University of Washington. 76 pp.
- 17 McDermott, S.F., and S.A. Lowe. 1997. The reproductive cycle and sexual maturity of Atka mackerel
18 (*Pleurogrammus monopterygius*) in Alaska waters. Fish. Bull. U.S. 95:231-233.
- 19 McFarlane, G.A., and R.J. Beamish. 1990. Effect of an external tag on growth of sablefish
20 (*Anoplopoma fimbria*) and consequences to mortality and age at maturity. Canadian J. Fish.
21 Aquat. Sci. 47:1551-1557.
- 22 McFarlane, G.A., and W.D. Nagata. 1988. Overview of sablefish mariculture and its potential for
23 industry. Pp. 105-120 in *Proceedings of the Fourth Alaska Aquaculture Conference*, Alaska
24 Sea Grant Report 88-4 University of Alaska Fairbanks, Fairbanks, AK 99775.
- 25 Megrey, B.A., A.B. Hollowed, S.R. Hare, S.A. Macklin, and P.J. Stabeno. 1996. Contributions of FOCI
26 research to forecasts of year-class strength of walleye pollock in Shelikof Strait, Alaska. Fish.
27 Oceanogr. 5:189-203.
- 28 Merati, N., and R.D. Brodeur. 1997. Feeding habits and daily ration of juvenile walleye pollock in the
29 western Gulf of Alaska. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 126. pp. 65-80.
- 30 Merrick, R.L., and D.G. Calkins. 1996. Importance of juvenile walleye pollock, *Theragra*
31 *chalcogramma*, in the diet of Gulf of Alaska Steller sea lions, *Eumetopias jubatus*. Pp.
32 153-166 in U.S. Dep. of Commer., NOAA Tech. Rep. NMFS 126.
- 33 Methot, R.D. 1990. Synthesis model: An adaptable framework for analysis of diverse stock assessment
34 data. INPFC Bull. 50:259-277.
- 35 Morris, B.F. 1981. An assessment of the living marine resources of the central Bering Sea and potential
36 resource use conflicts between commercial fisheries and Petroleum development in the
37 Navarin Basin, Proposed sale No. 83. In U.S. Dep. Commer., NOAA, NMFS, Environmental
38 Assessment Division, P.O. Box 21668, Juneau, AK 99802.
- 39 Morris, B.F., M.S. Alton, and H.W. Braham. 1983. Living marine resources of the Gulf of Alaska: a
40 resource assessment for the Gulf of Alaska/Cook Inlet Proposed Oil and Gas Lease Sale 88. In
41 U.S. Dep. Commer., NOAA, NMFS.
- 42 Musienko, L.N. 1970. Razmnozheine i razvitie ryb Beringova morya (Reproduction and development of
43 Bering Sea fishes). Tr. Vses. Nauchno-issled. Inst. Morsk. Rybn. Koz. Okeanogr. 70:161-224
44 in P.A. Moiseev (ed.), Soviet fisheries investigations in the northeastern Pacific, Pt. 5,
45 available Natl. Tech. Info. Serv., Springfield, VA as TT 74-50127.
- 46 Nesis, K.N. 1987. Cephalopods of the world. TFH Publications, Neptune City, NJ, 351 p.
- 47 Nichol, D.G. 1994. Maturation and Spawning of female yellowfin sole in the Eastern Bering Sea.
48 Proceedings of the International Pacific Flatfish Symposium, Anchorage, AK. Alaska Sea

- 1 Grant College Program, University of Alaska, Fairbanks, 304 Eielson Building, Fairbanks, AK
2 99775.
- 3 Nichol, D.G. 1997. Effects of geography and bathymetry on growth and maturity of yellowfin sole,
4 *Pleuronectes asper*, in the eastern Bering Sea. Fish. Bull. 95:494-503.
- 5 OCSEAP. 1987. Marine Fisheries: resources and environments. The Gulf of Alaska: Physical
6 Environment and Biological Resources, D. W. Hood and S. T. Zimmerman, eds., Alaska
7 Office, Ocean Assessments Division, National Oceanic and Atmospheric Administration, U.S.
8 Department of Commerce, and the Alaska OCS Region Office, Minerals Management Service,
9 U.S. Department of the Interior, Washington, DC, pp. 417-458.
- 10 O'Connell, V.M. 1987. Reproductive seasons for some *Sebastes* species in Southeastern Alaska. Alaska
11 Dep. Fish Game Information Leaflet. 263:21.
- 12 O'Connell, V.M., and D.W. Carlile. 1993. Habitat-specific density of adult yelloweye rockfish *Sebastes*
13 *ruberrimus* in the eastern Gulf of Alaska. Fish. Bull. 91:304-309.
- 14 O'Connell, V.M., D. Carlile, and C. Brylinsky. 1999. Demersal shelf rockfish. In Stock Assessment
15 and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of
16 Alaska Plan Team, pp. 427-466. (North Pacific Fishery Management Council, 605 W. 4th
17 Avenue, Suite 306, Anchorage, AK 99501)
- 18 O'Connell, V.M., and F.C. Funk. 1987. Age and growth of yelloweye rockfish (*Sebastes ruberrimus*)
19 landed in Southeastern Alaska. Pp. 171-185 in Proceedings of the International Rockfish
20 Symposium, B. R. Melteff (ed.), Alaska Sea Grant Report 87-2 Alaska Sea Grant.
- 21 Olla, B.L., M.W. Davis, C.H. Ryer, and S.M. Sogard. 1995. Behavioural responses of larval and
22 juvenile walleye pollock (*Theragra chalcogramma*): possible mechanisms controlling
23 distribution and recruitment. International Council for the Exploration of the Sea Marine
24 Science Symposium. 201. pp. 3-15.
- 25 Orcutt, H.G. 1950. The life history of the starry flounder, *Platichthys stellatus* (Pallas). Calif. Div. Fish
26 Game Fish. Bull. 78:64.
- 27 Percy, W.G. 1962. Egg masses and early development stages of the scorpaenid fish *Sebastolobus*. J.
28 Fish. Res. Board Canada. 19:1169-1173.
- 29 Perez, M.A. 1990. Review of marine mammal population and prey information for Bering Sea
30 ecosystem studies. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-186. 81 pp.
- 31 Perez, M.A., and M.A. Bigg. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North
32 America. Fish. Bull. 84:959-973.
- 33 Pitcher, K.W. 1980a. Stomach contents and feces as indicators of harbor seal, *Phoca vitulina*, foods in
34 the Gulf of Alaska. Fish. Bull. 78:797-798.
- 35 Pitcher, K.W. 1980b. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish.
36 Bull. 78:544-549.
- 37 Pitcher, K.W. 1981. Prey of the Steller sea lion, *Eumetopias jubatus*, in the Gulf of Alaska. Fish. Bull.
38 79:467-472.
- 39 Radchenko, V.I. 1992. The role of Squid in the pelagic ecosystem of the Bering Sea. Okeanologiya.
40 32:1093-1101.
- 41 Rickey, M.H. 1995. Maturity, spawning and seasonal movement of arrowtooth flounder, *Atheresthes*
42 *stomias*, off Washington. Fish. Bull. 93:127-138.
- 43 Ronholt, L.L., K. Wakabayashi, T.K. Wilderbuer, H. Yamaguchi, and K. Okada. 1985. Results of the
44 cooperative U.S.-Japan groundfish assessment survey in Aleutian Islands water, June-
45 November 1980. Unpubl. manuscr., U.S. Dep. Commer., NOAA, Northwest and Alaska
46 Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115. 303 pp.
- 47 Rosenthal, R.J., V.M. O'Connell, and M.C. Murphy. 1988. Feeding ecology of ten species of rockfishes
48 (*Scorpaenidae*) from the Gulf of Alaska. California Fish and Game. 74:16-37.

- 1 Rutecki, T.L., and E.R. Varosi. 1997. Migrations of juvenile sablefish, *Anoplopoma fimbria*, in
2 southeast Alaska. *In* Biology and Management of Sablefish, *Anoplopoma fimbria*, M. E.
3 Wilkins, M. W. Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
- 4 Schneider, D.C., and V.P. Shuntov. 1993. The trophic organization of the marine bird community in the
5 Bering Sea. *Rev. Fish. Sci.* 1:311-335.
- 6 Schumacher, J. D., P.J. Stabeno, and S.J. Bograd. 1993. Characteristics of an eddy over a continental
7 shelf: Shelikof Strait, Alaska. *J. Geophys. Res.* 98:8395-8404.
- 8 Shimada, A.M., and D.K. Kimura. 1994. Seasonal movements of Pacific cod (*Gadus macrocephalus*) in
9 the eastern Bering Sea and adjacent waters based on tag-recapture data. *Fish. Bull.* 92:800-
10 816.
- 11 Shuntov, V.P., A.F. Volkov, O.S. Temnykh, and Y.P. Dulepova. 1993. Pollock in the ecosystem of the
12 far eastern seas. *Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr. (TINRO)*,
13 Vladivostok. 426.
- 14 Sigler, F.A., J.T. Fujioka, and S.A. Lowe. 1999. Alaska sablefish assessment for 2000. *In* Stock
15 Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering
16 Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team, pp. 469-518. (North
17 Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 18 Sigler, M.F., S.A. Lowe, and C.R. Kastle. 1997. Age and depth differences in the age-length
19 relationship of sablefish, *Anoplopoma fimbria*, in the Gulf of Alaska. Pp. 55-63 *in* Biology
20 and Management of Sablefish, *Anoplopoma fimbria*, (Papers from the International
21 Symposium on the Biology and Management of Sablefish, Seattle, Washington, 13-15 April
22 1993) M. E. Wilkins, M. W. Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS
23 130.
- 24 Sinclair, E.H., G.A. Antonelis, B.W. Robson, R.R. Ream, and T.R. Loughlin. 1997. Northern fur seal
25 predation on juvenile walleye pollock. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 126.
- 26 Sinclair, E.H., T. Loughlin, and W. Pearcy. 1994. Prey selection by northern fur seals (*Callorhinus*
27 *ursinus*) in the eastern Bering Sea. *Fish. Bull.* 92:144-156.
- 28 Sobolevsky, Y.I. 1996. Species composition and distribution of squids in the western Bering Sea. Pp.
29 135-141 *in* Ecology of the Bering Sea: a review of Russian literature, O.A. Mathisen, K.O.
30 Coyle (eds.) Alaska Sea Grant College Program Report 96-01 University of Alaska Fairbanks,
31 Fairbanks, AK 99775.
- 32 Sogard, S.M., and B.L. Olla. 1993. Effects of light, thermoclines and predator presence on vertical
33 distribution and behavioral interactions of juvenile walleye pollock, *Theragra chalcogramma*
34 Pallas. *J. Exp. Mar. Biol. Ecol.* 167:179-195.
- 35 Sogard, S.M., and B.L. Olla. 1996. Food deprivation affects vertical distribution and activity of marine
36 fish in a thermal gradient: potential energy-conserving mechanisms. *Mar. Ecol. Prog. Ser.*
37 133:43-55.
- 38 Springer, A.M. 1992. A review: Walleye pollock in the North Pacific - how much difference do they
39 really make? *Fish. Oceanogr.* 1:80-96.
- 40 Springer, A.M., D.G. Rose, D.S. Lloyd, C.P. McRoy, and E.C. Murphy. 1986. Seabird responses
41 to fluctuating prey availability in the eastern Bering Sea. *Marine Ecology Progress Series*
42 32:1-12.
- 43 Stabeno, P.J., R.K. Reed, and J.D. Schumacher. 1995. The Alaska Coastal Current: continuity of
44 transport and forcing. *J. Geophys. Res.* 100:2477-2485.
- 45 Tanasichuk, R.W. 1997. Diet of sablefish, *Anoplopoma fimbria*, from the southwest coast of Vancouver
46 Island. *in* Biology and Management of Sablefish, *Anoplopoma fimbria*, M.E. Wilkins, M.W.
47 Saunders (eds.), U.S. Dep. Commer., NOAA Tech. Rep. NMFS 130.
- 48 Templeman, W. 1973. Distribution and abundance of the Greenland halibut, *Rheinhardtius*

- 1 *hippoglossoides* (Walbaum) in the Northwest Atlantic. Internatl. Comm. Northwest Atl. Fish.
2 Res. Bull. 10:82-98.
- 3 Theilacker, G.H., K.M. Bailey, M.F. Canino, and S.M. Porter. 1996. Variations in larval walleye
4 pollock feeding and condition: a synthesis. Fish. Oceanogr. 5:112-123.
- 5 Thompson, G.G., and M.W. Dorn. 1999. Assessment of the Pacific cod in the eastern Bering Sea and
6 Aleutian Islands area. In Stock Assessment and Fishery Evaluation Report for the Groundfish
7 Resources of the Bering Sea/Aleutian Islands Region. Bering Sea/Aleutian Islands Plan Team,
8 pp. 151-230. (North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
9 Anchorage, AK 99501)
- 10 Thompson, G.G., and R.D. Methot. 1993. Pacific cod. In Stock assessment and fishery evaluation
11 report for the groundfish resources of the Bering Sea/Aleutian Islands region as projected for
12 1994. Bering Sea/Aleutian Islands Plan Team (eds.), North Pacific Fishery Management
13 Council, 605 W. 4th Avenue, Suite, 306, Anchorage, AK 99501.
- 14 Thompson, G.G., and A.M. Shimada. 1990. Pacific cod. Pp. 44-66 in Condition of groundfish resources
15 of the eastern Bering Sea-Aleutian Islands region as assessed in 1988, L. L. Low, R. E. Narita
16 (eds.), U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-178.
- 17 Thompson, G.G., and H.H. Zenger. 1994. Pacific cod. In Stock assessment and fishery evaluation report
18 for the groundfish resources of the Gulf of Alaska as projected for 1995. Gulf of Alaska Plan
19 Team (eds.), North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
20 Anchorage, AK 99501.
- 21 Thompson, G.G., H.H. Zenger, and M.W. Dorn. 1999. Assessment of the Pacific cod in the Gulf of
22 Alaska. In Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of
23 the Gulf of Alaska. Gulf of Alaska Plan Team, pp. 105-184. (North Pacific Fishery
24 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 25 Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1997a. Flatfish. In Stock Assessment and Fishery
26 Evaluation Report for the Groundfish Resources of the Gulf of Alaska as Projected for 1998.
27 Gulf of Alaska Plan Team, eds., pp. 165-192. North Pacific Fishery Management Council, 605
28 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
- 29 Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1997b. Arrowtooth Flounder. Stock Assessment and
30 Fishery Evaluation Report for the 1998 Gulf of Alaska Groundfish Fishery, Gulf of Alaska
31 Plan Team, ed., North Pacific Fishery Management Council, 605 W. 4th Avenue, Suite 306,
32 Anchorage, AK 99501, p. 17.
- 33 Turnock, B.J., T.K. Wilderbuer, and E.S. Brown. 1999. Arrowtooth flounder. In Stock Assessment and
34 Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. Gulf of Alaska
35 Plan Team, pp. 225-254. (North Pacific Fishery Management Council, 605 W. 4th Avenue,
36 Suite 306, Anchorage, AK 99501)
- 37 Waldron, K.D., and B.M. Vinter. 1978. Ichthyoplankton of the eastern Bering Sea. U.S. Dep. Commer.,
38 NMFS Proc. Rep., 88 pp.
- 39 Walline, P.D. 1983. Ph.D. Dissertation. University of Washington. 144 pp.
- 40 Walters, G.E., and T.K. Wilderbuer. 1997. Flathead sole. In Stock Assessment and Fishery Evaluation
41 Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected
42 for 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 271-296. (North Pacific Fishery
43 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 44 Wespestad, V.G. 1993. The status of Bering Sea pollock and the effect of the Donut Hole fishery. Fish.
45 18:18-25.
- 46 Wespestad, V.G., L.W. Fritz, W.J. Ingraham, and B.A. Megrey. 1997a. On Relationships between
47 Cannibalism, climate variability, physical transport and recruitment success of Bering Sea
48 Walleye Pollock, *Theragra chalcogramma*. ICES International Symposium, Recruitment

- 1 Dynamics of exploited marine populations: physical-biological interactions. Baltimore, MD.
2 Wespestad, V.G., J.N. Ianelli, L. Fritz, T. Honkalehto, N. Williamson, and G. Walters. 1997b. Bering
3 Sea-Aleutian Islands walleye pollock assessment for 1998. *In* Stock Assessment and Fishery
4 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
5 Projected for 1998. Bering Sea/Aleutian Islands Plan Team, eds., pp. 35-120. (North Pacific
6 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501).
- 7 Wespestad, V.G., and J.M. Terry. 1984. Biological and economic yields for Bering Sea walleye pollock
8 under different fishing regimes. *N. Amer. J. Fish. Manage.* 4:204-215.
- 9 Westrheim, S.J. 1996. On the Pacific cod (*Gadus macrocephalus*) in British Columbia waters, and a
10 comparison with Pacific cod elsewhere, and Atlantic cod (*G. morhua*). *Canadian Tech. Rep.*
11 *Fish. Aquat. Sci.* 2092:390.
- 12 Wilderbuer, T.K. 1997. Yellowfin sole. *In* Stock Assessment and Fishery Evaluation Report for the
13 Groundfish Resources of the Bering Sea/Aleutian Islands Regions as Projected for 1998.
14 Bering Sea/Aleutian Islands Plan Team, eds., pp. 159-186. North Pacific Fishery Management
15 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
- 16 Wilderbuer, T.K., and T.M. Sample. 1997. Arrowtooth flounder. Stock Assessment and Fishery
17 Evaluation Report for the Groundfish Resources of the Bering Sea and Aleutian Islands
18 Regions as Projected for 1998, Bering Sea and Aleutian Islands Plan Team, ed., North Pacific
19 Fishery Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, Alaska 99501, pp.
20 220-244.
- 21 Wilderbuer, T.K., and T.M. Sample. 1999. Arrowtooth flounder. *In* Stock Assessment and Fishery
22 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region.
23 Bering Sea/Aleutian Islands Plan Team, pp. 315-348. (North Pacific Fishery Management
24 Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 25 Wilderbuer, T.K., and G.E. Walters. 1997. Rock sole. Pp. 245-270 *in* Stock Assessment and Fishery
26 Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions as
27 Projected for 1998. Bering Sea/Aleutian Islands Plan Team (eds.). North Pacific Fishery
28 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
- 29 Wilderbuer, T.K., and G.E. Walters. 1992. Rock sole. *in* Stock Assessment and Fishery Evaluation
30 Report for the Groundfish Resources of the Bering Sea and Aleutian Islands Regions as
31 Projected for 1993. Bering Sea and Aleutian Islands Plan Team (eds.). North Pacific Fishery
32 Management Council, 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501.
- 33 Wilderbuer, T.K., and G.E. Walters. 1999. Rock sole. *In* Stock Assessment and Fishery Evaluation
34 Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. Bering
35 Sea/Aleutian Islands Plan Team, pp. 349-390. (North Pacific Fishery Management Council,
36 605 W. 4th Avenue, Suite 306, Anchorage, AK 99501)
- 37 Wilderbuer, T.K., G.E. Walters, and R.G. Bakkala, R. G. 1992. Yellowfin sole, *Pleuronectes asper*, of
38 the Eastern Bering Sea: Biological Characteristics History of Exploitation, and Management.
39 *Mar. Fish. Rev.* 54:1-18.
- 40 Wolotira, R.J.J., T.M. Sample, S.F. Noel, and C.R. Iten. 1993. Geographic and bathymetric distributions
41 for many commercially important fishes and shellfishes off the west coast of North America,
42 based on research survey and commercial catch data, 1912-1984. U.S. Dep. Commer., NOAA
43 Tech. Memo. NMFS-AFSC-6. 184 pp.
- 44 Yang, M.S. 1993. Food habits of the commercially important groundfishes in the Gulf of Alaska in
45 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-22. 150 pp.
- 46 Yang, M.S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S.
47 Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60. 105 pp.
- 48 Zhang, C.I. 1987. Biology and Population Dynamics of Alaska plaice, *Pleuronectes quadrierculatus*, *in*

1 the Eastern Bering Sea. Ph.D. University of Washington, 3707 Brooklyn Avenue, Seattle, WA
2 98195, 225 pp.
3 Zimmermann, M. 1997. Maturity and fecundity of arrowtooth flounder, *Atheresthes stomias*, from the
4 Gulf of Alaska. Fish. Bull. 95:598-611.
5 Zolotov, O.G. 1993. Notes on the reproductive biology of *Pleurogrammus monopterygius* in
6 Kamchatkan waters. J. of Ichthy. 33:25-37.

APPENDIX 3 STELLER SEA LION CASE STUDY

Annual estimates of prey availability for the entire BSAI and GOA

The current estimate of groundfish biomass in 1999 in the BSAI/GOA is approximately 21.8 million tons. The estimated annual consumption of forage by 43,000 Steller sea lions is 399,700 tons (based on the approach reported in Winship 2000). The current estimate of the ratio of biomass consumed by Steller sea lions to biomass of groundfish is approximately 1:54. The estimated equilibrium theoretical unfished stock size for 17 groundfish stocks combined was likely to be no more than 37.6 million tons (NMFS 2000), although it must be recognized that this figure represents an estimate of a hypothetical condition (i.e., the amount of groundfish biomass in the action area at this time had there been no commercial fishery ever prosecuted in this area). The estimated historical abundance of Steller sea lions (prior to their recent decline) is approximately 184,000 animals (Loughlin et al. 1984). The 1999 estimate of abundance for Steller sea lions from Winship (2000) is about 43,000 animals or roughly 23% of its historical carrying capacity, where annual consumption by sea lions in 1999 was estimated at 399,700 tons. Therefore, by analogy, 200,000 animals would be expected to eat approximately 1.71 million tons of forage annually. While crude, the estimated ratio of biomass consumed by 184,000 Steller sea lions to biomass of groundfish in an unfished environment is approximately 1:21. To interpret this estimate, it must be assumed that Steller sea lions only eat groundfish, which of course is a conservative assumption. With this assumption, it could be argued that a healthy population of Steller sea lions requires no more than 22 times as much forage as it is capable of consuming in a single year.

Another approach to estimating what the multiplier in going from prey consumed to prey available should be for a healthy marine mammal population was reported by Fowler (1999). The information reported in Fowler (1999) was extracted from Perez and McAlister (1993). Perez and McAlister reported that 32,000 Steller sea lions would consume 140,700 tons of forage. Extrapolating to the consumption of 184,000 Steller sea lions leads to a consumption estimate of 809,600 tons of forage. If it is again assumed that the unfished, equilibrium biomass of groundfish is 37.6 million tons, then the multiplier of groundfish forage available to Steller sea lions forage consumed is 46.

At present it is not possible to evaluate the relative merits of the two multipliers. Therefore, lacking alternatives, two approaches are proposed regarding the inference as to whether the current multiplier of forage available to forage consumption for a species listed under the ESA is indicative of a population that has adequate access to forage. One would be to use the average value of the two multipliers. In this case, that would be a multiplier of 34 (i.e., $(22+46)/2$). The other approach would be to use the more conservative estimate, as the ESA requires NMFS to err on the side of the animal when interpreting available data. The current ratio of biomass consumed by SSL to biomass available is 1:54 or a multiplier of 55. In either case, the current multiplier is greater than either of the two threshold values. This analysis, given uncertainties as discussed above, is therefore consistent with the conclusion that at the global or Action Area scale of the BSAI and GOA, Steller sea lions have adequate forage available to them to recover to optimal population levels.

Monthly estimates of prey availability for critical habitat

Average monthly estimates of biomass of pollock, Atka mackerel, and Pacific cod in critical habitat are

1 reported in NMFS (2000). Alaska Fisheries Science Center. Biological Opinion Questions and Answers,
2 unpublished report). In addition, monthly consumption estimates of a population of 43,000 Steller sea
3 lions are reported in Table based on the methods reported in Winship (2000). The monthly estimates of
4 biomass range from a low of 2.1 million tons in June to a high of 6.4 million tons in February (Table 2).
5 Steller sea lion consumption estimates range from a low of 25,664 tons in June to a high of 35,787 tons
6 in March. The average percent of biomass consumed was 0.88% percent or a ratio of 1:113 biomass
7 consumed to biomass available. The lowest percentage of the twelve month period was in 0.52% in
8 February, while the highest percentage was 1.48%. The corresponding multipliers for these percent
9 consumption rates are 192 and 68.

10
11 A worst-case estimate of the percent of biomass of pollock, Atka mackerel, and Pacific cod in critical
12 habitat, which was based on the upper 95% confidence interval for consumption and the lower 95%
13 confidence interval for biomass available, ranges from a low of 1.27% to a high of 3.12% (i.e.,
14 multipliers of forage consumed to forage available of 79 and 32). The average percent consumption
15 using these data was 2.01% or a ratio of 1:49 biomass consumed to biomass available (i.e., multiplier of
16 50).

17
18 It should be emphasized that these estimates of percent biomass consumed are likely to be positively
19 biased (i.e., over-estimated) because the diet of Steller sea lions includes species other than the three
20 considered in this analysis and because the foraging area of Steller sea lions in the western population is
21 not limited to critical habitat. It should be noted that the associated estimates of precision of Steller sea
22 lion consumption are likely negatively biased because the variance associated with the abundance
23 estimate, age structure, and energetic needs have not been included in the analysis (as estimates for these
24 statistics are not available). Further, in interpreting the results of these data it is necessary to assume that
25 forage is adequately available to Steller sea lions throughout critical habitat. The information needed to
26 test this assumption are not available. Therefore, the degree to which heterogeneity in the distribution of
27 biomass confounds the interpretation of forage availability in critical habitat for Steller sea lions and the
28 effects of commercial fishing on forage availability for SSL cannot be assessed at this time.

29
30 The best available data indicate that the current multiplier varies monthly between 68 and 191, where the
31 multiplier is never less than 46. Further, using the conservative data on forage consumed to forage
32 available, the estimated multipliers range over the 12 month period between 32 and 79. In this case, only
33 one of the monthly multipliers is less than the threshold of a multiplier of 34, while four of the monthly
34 multipliers are less than the more conservative threshold of 46. As noted in NMFS (2000), there is
35 considerable uncertainty in trying to estimate monthly estimates of Steller sea lion consumption and
36 biomass of pollock, Pacific cod, and Atka mackerel and in estimating the fraction of the total biomass of
37 these three prey species that occur in Critical Habitat for Steller sea lions. However, given uncertainty
38 consistent with previous analyses, the available data on monthly consumption requirements relative to the
39 total biomass of three important prey species in critical habitat are consistent with the conclusion that
40 forage availability (without consideration regarding species composition or spatial distribution) is
41 adequate to support the recovery of Steller sea lions to optimal population levels.

42
43 **Table 1.** Summary of Steller sea lion consumption estimates by month (based on Winship 2000). The
44 population size assumed in this analysis was 43,127 animals post-pupping.

Month	Biomass (tons)	Month	Biomass (tons)
Jan	35,093	July	32,275
Feb	33,407	Aug	32,990
Mar	35,787	Sept	33,057
Apr	34,125	Oct	34,497
May	34,127	Nov	33,775
Jun	25,664	Dec	34,872

Table 2. Summary of biomass estimates of pollock, Pacific cod, and Atka mackerel in Critical Habitat (see NMFS 2000)

Month	Biomass (tons)	% Consumed	Month	Biomass (tons)	% Consumed
Jan	6,012,615	0.58	July	2,183,687	1.48
Feb	6,383,644	0.52	Aug	2,538,000	1.30
Mar	6,397,301	0.56	Sept	3,083,889	1.07
Apr	5,961,198	0.57	Oct	3,750,186	0.92
May	3,851,215	0.89	Nov	4,456,918	0.76
Jun	2,056,445	1.25	Dec	5,100,096	0.68

The analyses that we have conducted in this biological opinion suggests that competition as the result of an overall prey removal as allowed by the FMP does not adversely modify critical habitat. Rather, this analysis raises the following issues:

1. The abundance of any species in a particular space at a particular time is finite. Therefore, an activity that can remove hundreds of pounds in a single tow and thousands of tons of fish per day must, for short periods of time (hours to days), reduce the biomass of the targeted fish remaining in the immediate area. By extension, it is reasonable to assume that, as fishing effort increases or is concentrated in a particular area in a specific period of time, the extent and duration of those reductions would increase.
2. The likelihood of locally depleting a fish resource increases when that resource is patchily distributed. An assumption in our analyses suggested that the degree to which heterogeneity in the distribution of biomass occurs could confound the interpretation of forage availability in critical habitat for Steller sea lions. However, fish species are not

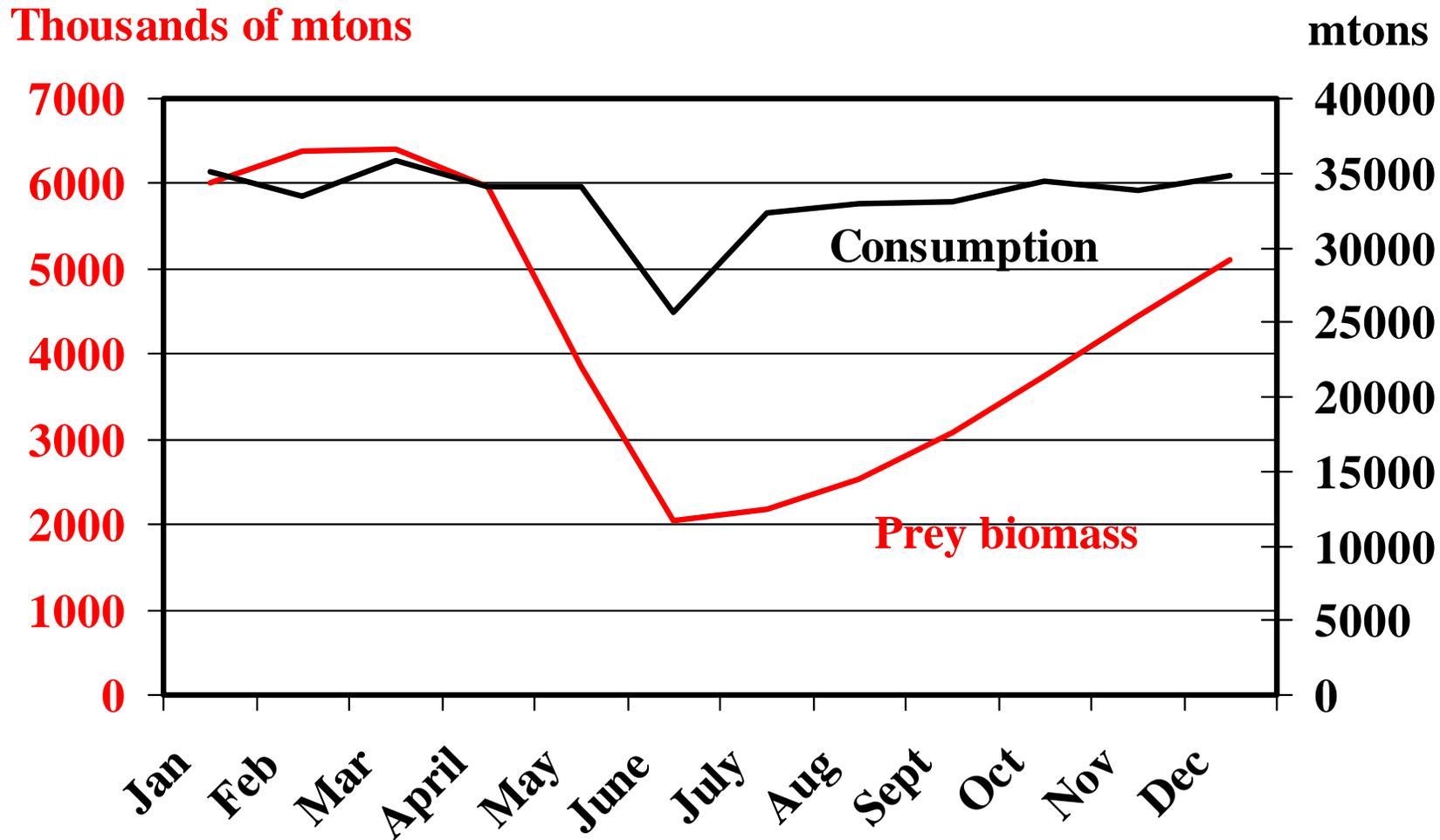
1 always homogeneously distributed throughout the water column. Instead, there are
2 specific areas that have larger numbers of fish and other areas that have limited numbers
3 of fish (Bakun 1996). Pollock and Atka mackerel are schooling fish that are patchily
4 distributed, within a school their biomass is very high while outside of a school their
5 densities are low. Fishing effort that targets schools of pollock or mackerel, and removes
6 a significant percentage of a school, is likely to reduce the biomass remaining in the
7 immediate area for at least a short period of time in a particular space.
8

9 This assumption is partially supported by the behavior of the fishing fleet itself. Fishing
10 vessels use electronic equipment on their vessels to locate large aggregations of pollock.
11 When vessels locate aggregations of pollock, they deploy their nets and continue to fish
12 that school until the density of the aggregation declines to the point at which continued
13 harvest becomes unprofitable.
14

- 15 3. If these reductions in schools of pollock or mackerel occur within the foraging areas of
16 the endangered western population of Steller sea lions, the reduced availability of prey is
17 likely to reduce the foraging effectiveness of sea lions, even if there is sufficient prey
18 overall as indicated by the previous analyses. We have stated in previous opinions that
19 the effects of these reductions become more significant the longer they last and the
20 reductions are likely to be most significant to adult female and juvenile Steller sea lions
21 during the winter months when these animals have their highest energetic demands.
22 Based on the available biomass during the critical winter months, it is apparent that
23 pollock availability is highest during the periods of the greatest energetic demands.
24

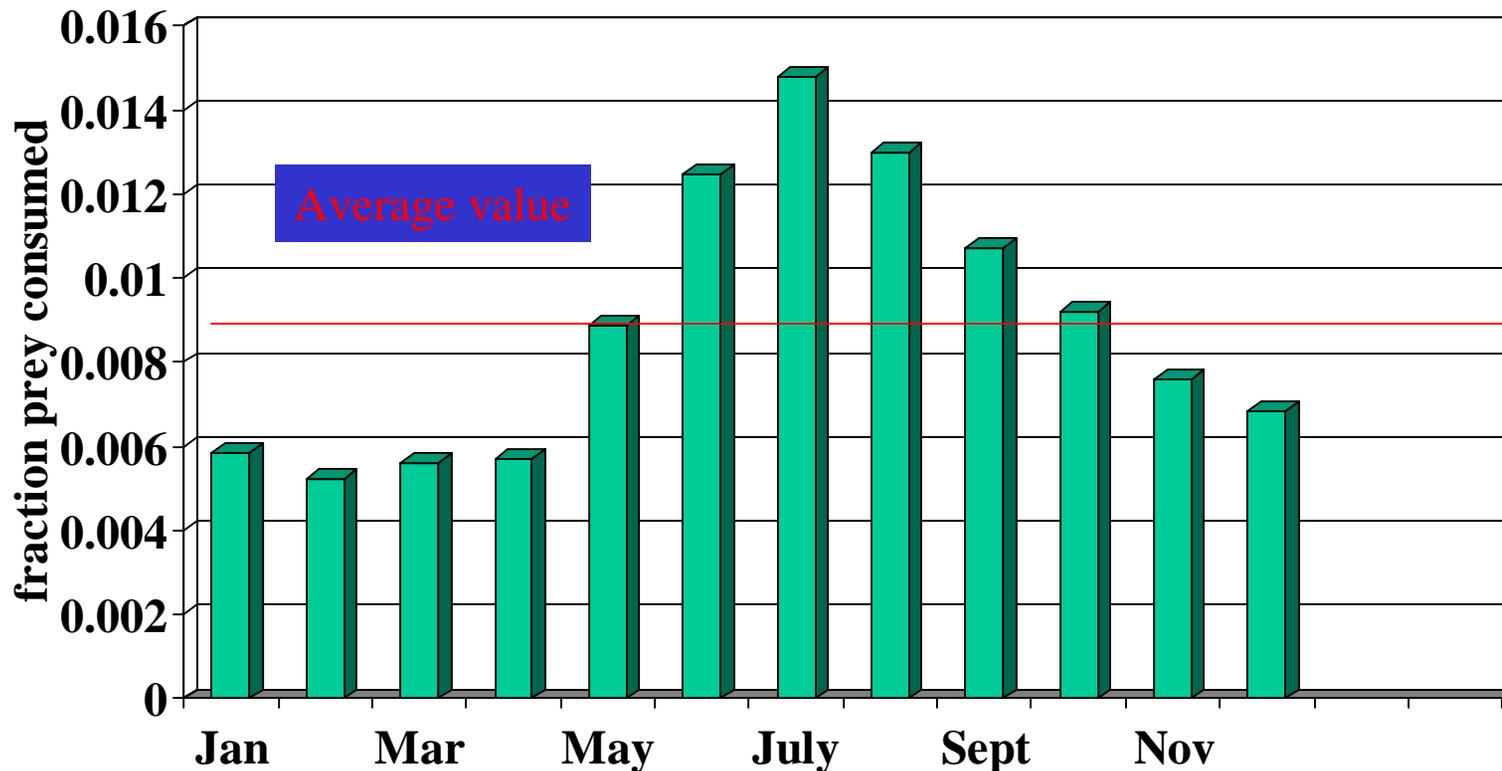
25 Based on the available information, it is reasonable to expect the groundfish fisheries do compete with
26 non-human consumers in the marine ecosystem in the BSAI and GOA. However, this competition occurs
27 as a result of the temporal and spatial behavior of the fishing fleet, and removals by this fleet on a local
28 level, not as a result of a decrease in total prey availability due to the reduction of total fish biomass. Our
29 current review is consistent with previous biological opinions that suggest that the harvesting ability of
30 the fishing fleet and of individual vessels may deplete the groundfish biomass on small, spatial and
31 temporal scales that would be expected to reduce the availability of groundfish to other, non-human
32 consumers.

Steller Sea Lion Consumption versus Prey Availability in Critical Habitat



**Biomass estimates of prey are for pollock, Pacific cod and Atka mackerel*

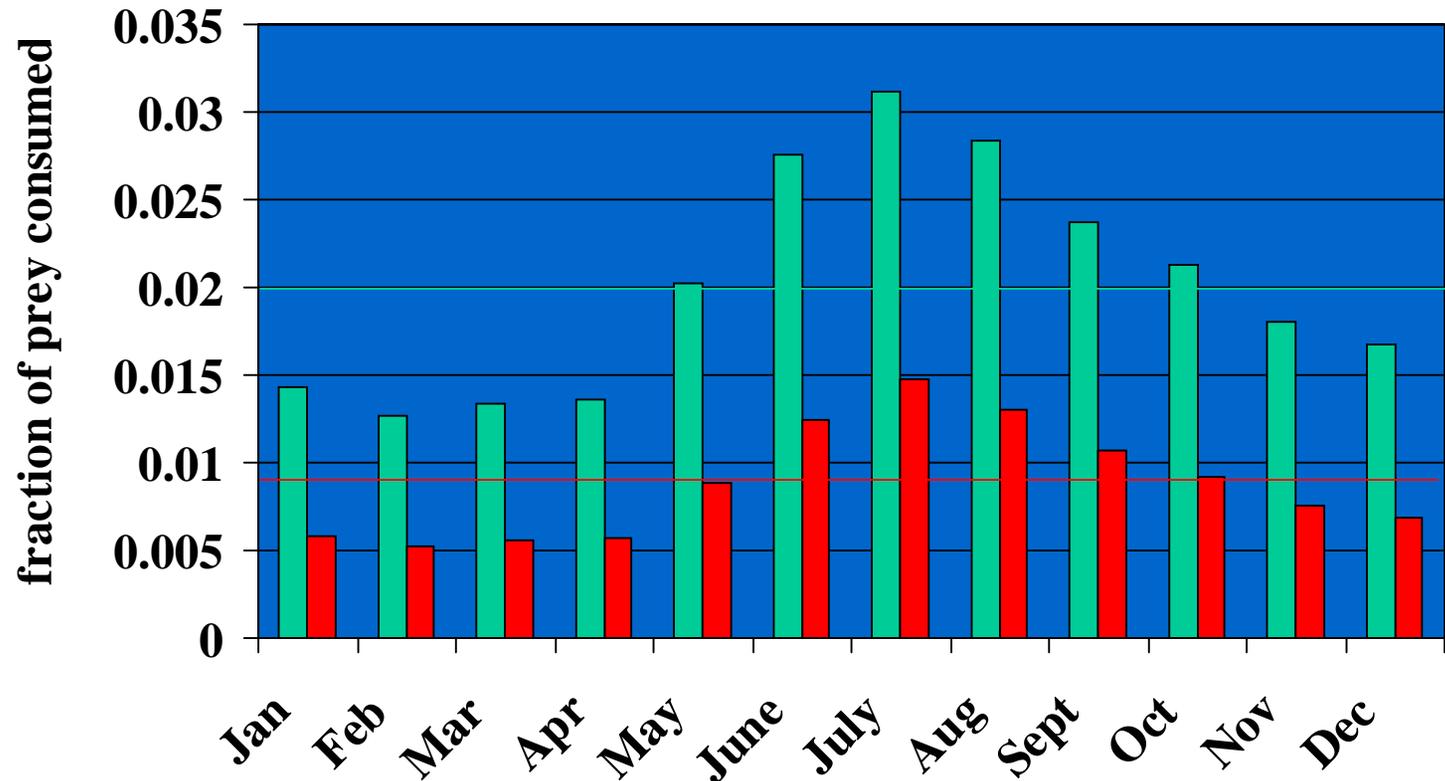
Fraction of Prey Consumed by Steller Sea Lions in Critical Habitat



**Biomass estimates of prey are for pollock, Pacific cod and Atka mackerel*

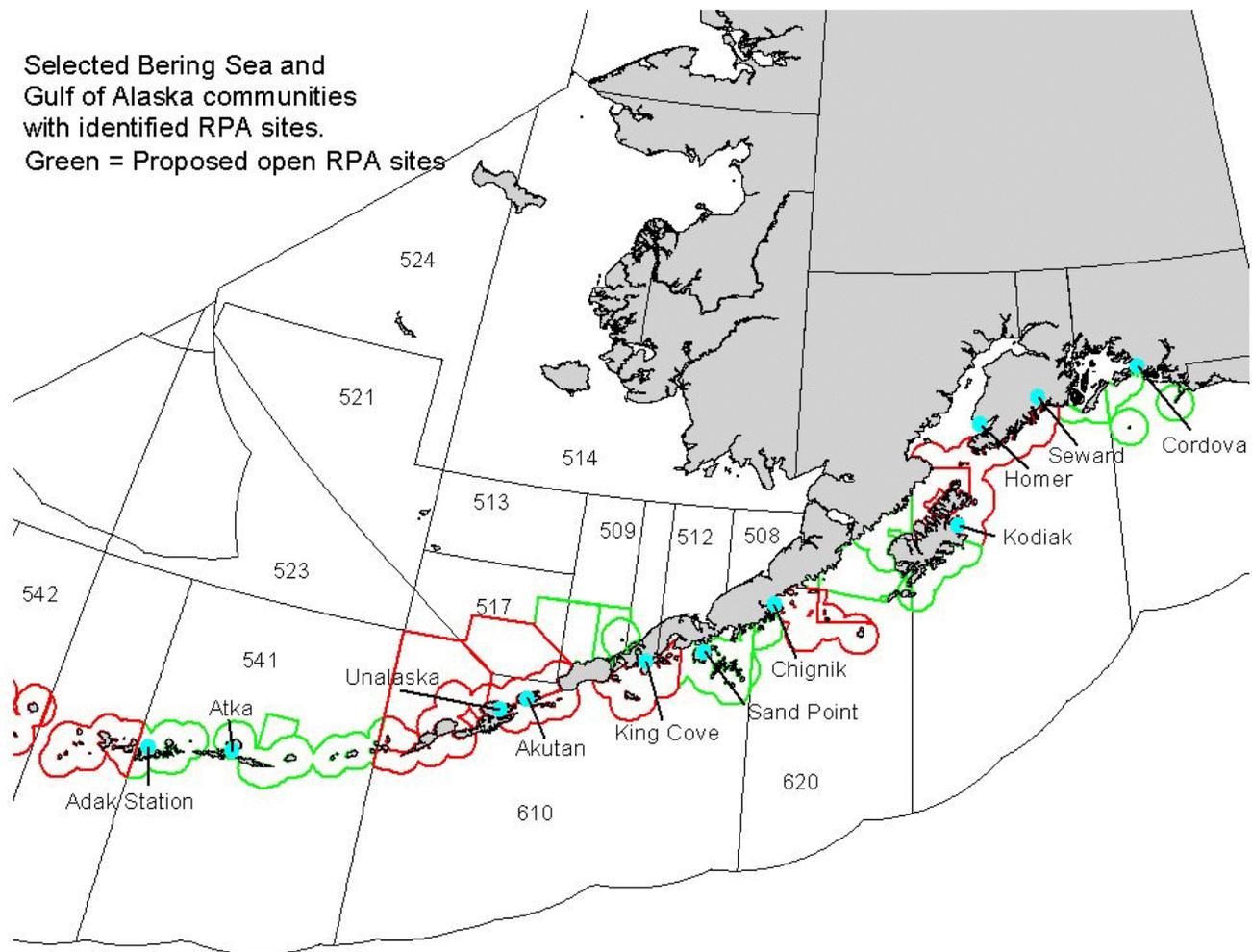
Steller Sea Lion: Fraction of prey Consumed

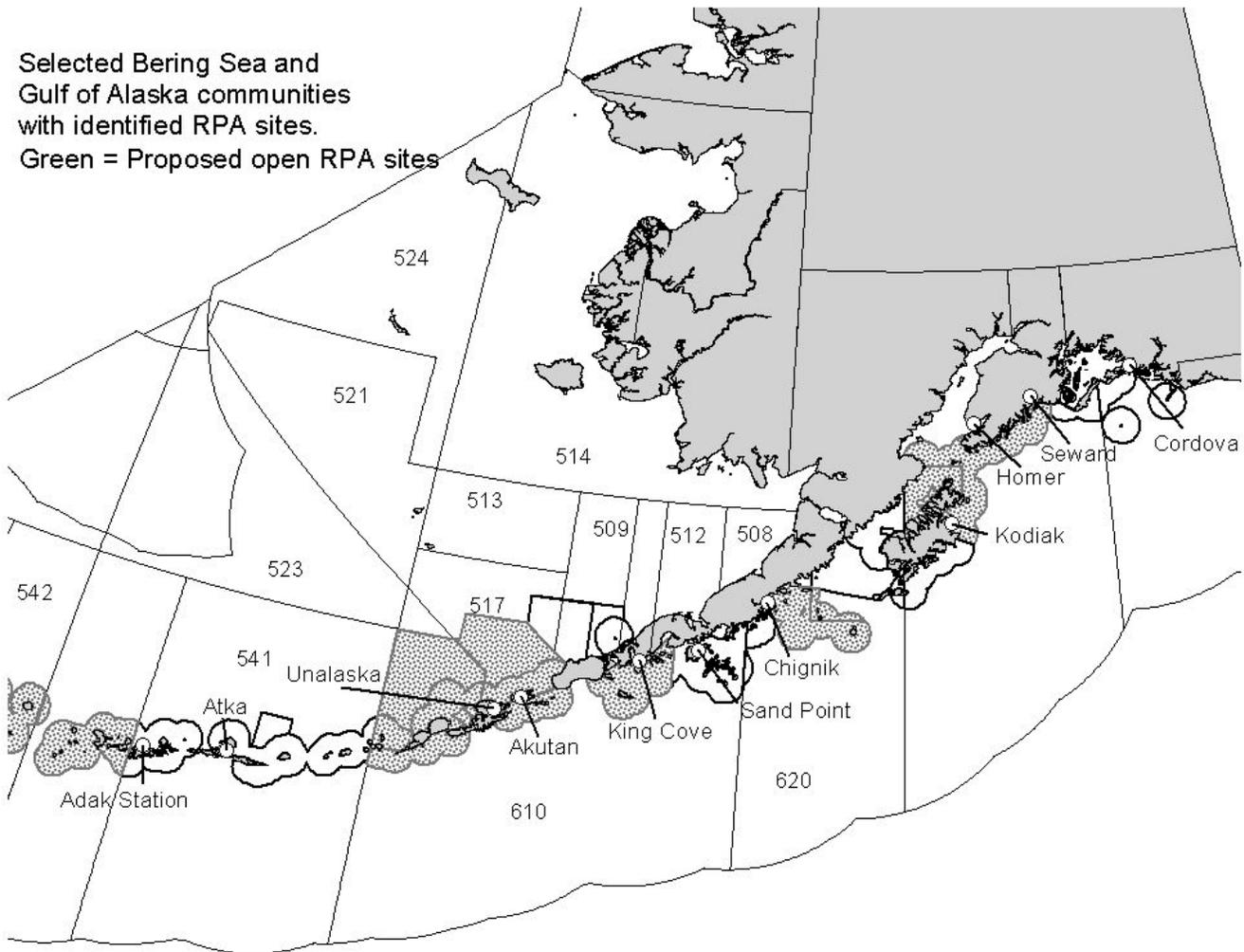
- 95% upper CI of prey consumed / 95% lower CI of prey biomass
- MLE of prey consumed / MLE of prey biomass



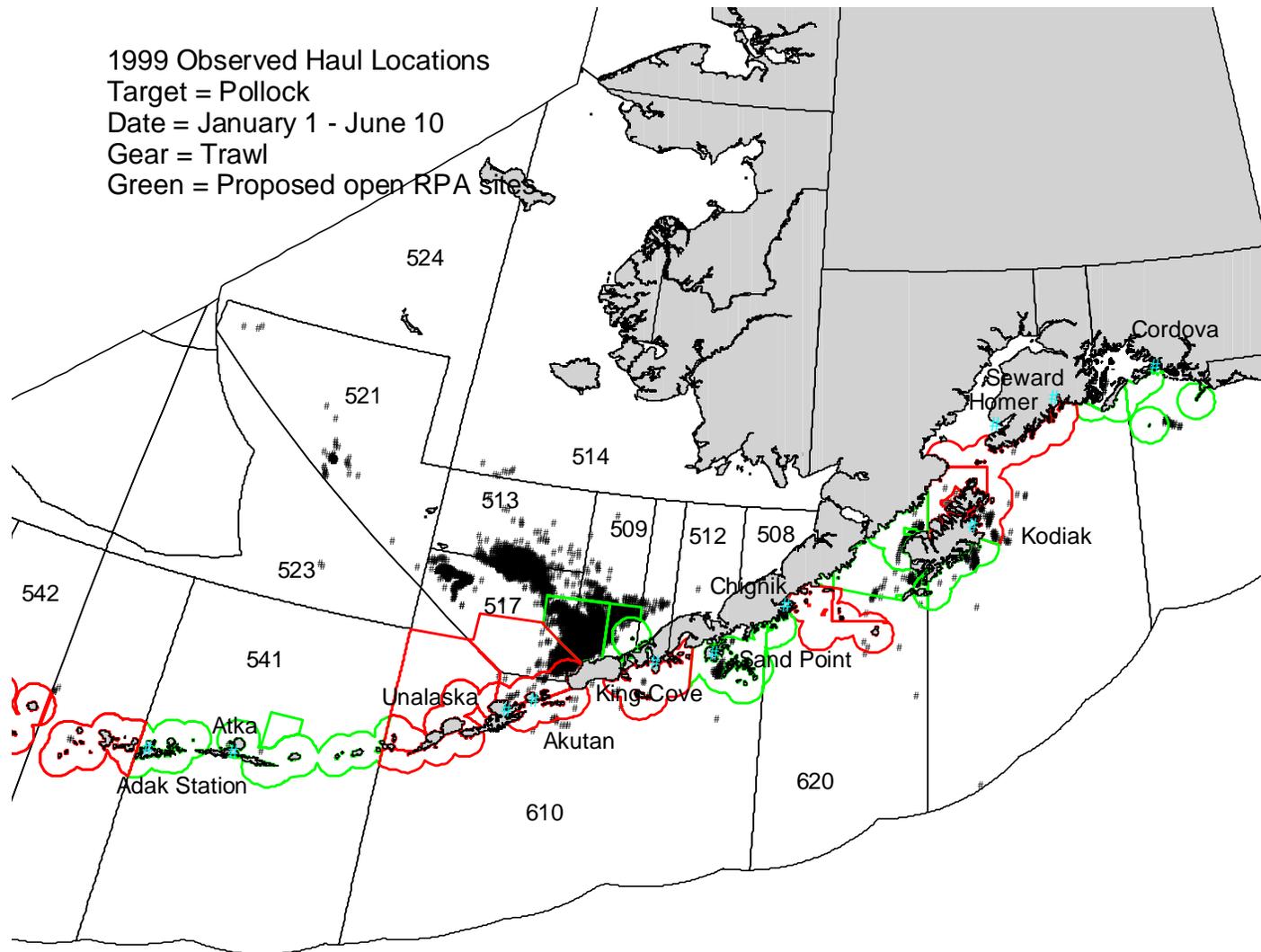
**Biomass estimates of prey are for pollock, Pacific cod and Atka mackerel*

APPENDIX 4 MAPS OF FISHING EFFORT AND CLOSURE AREAS

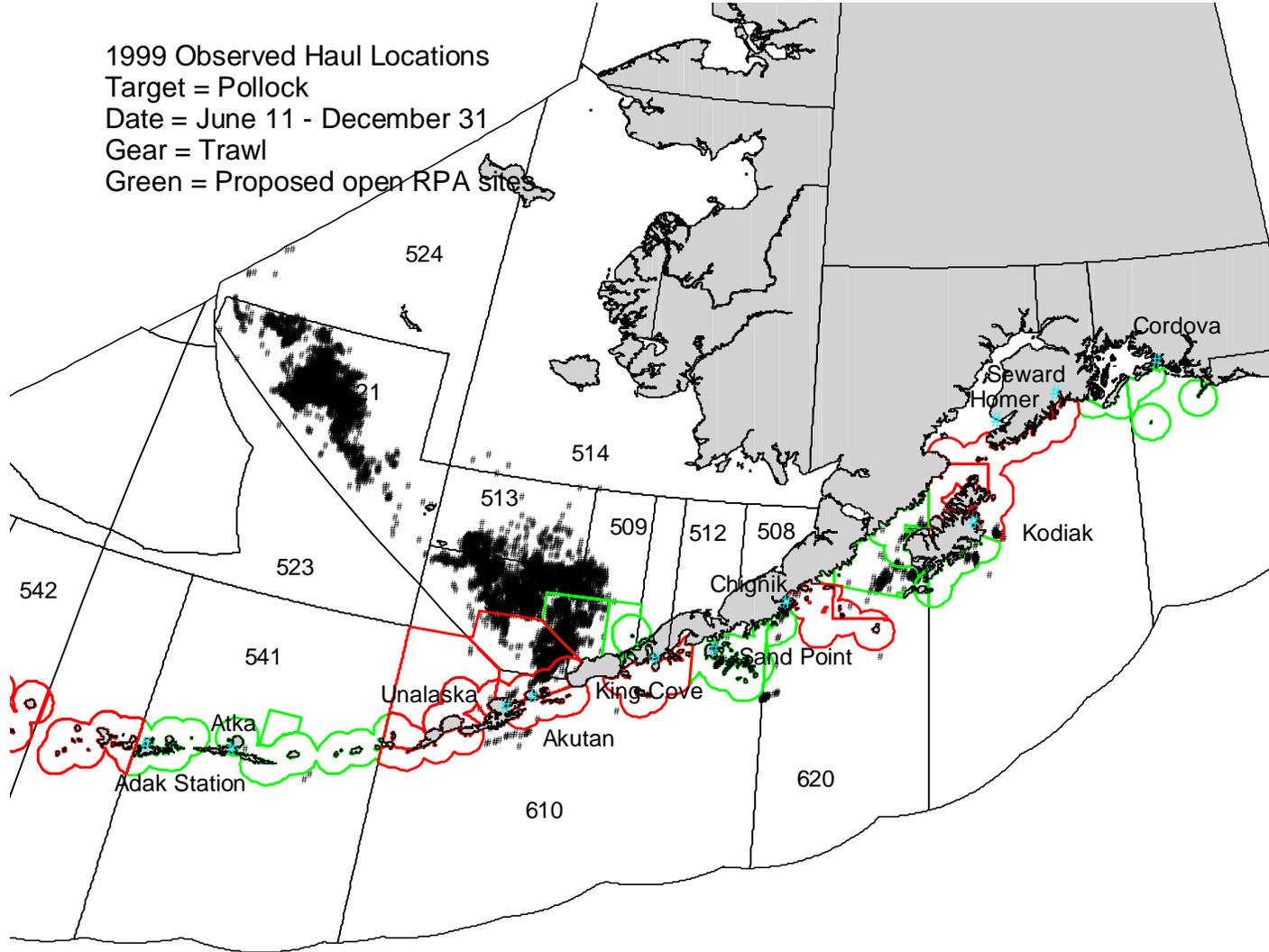




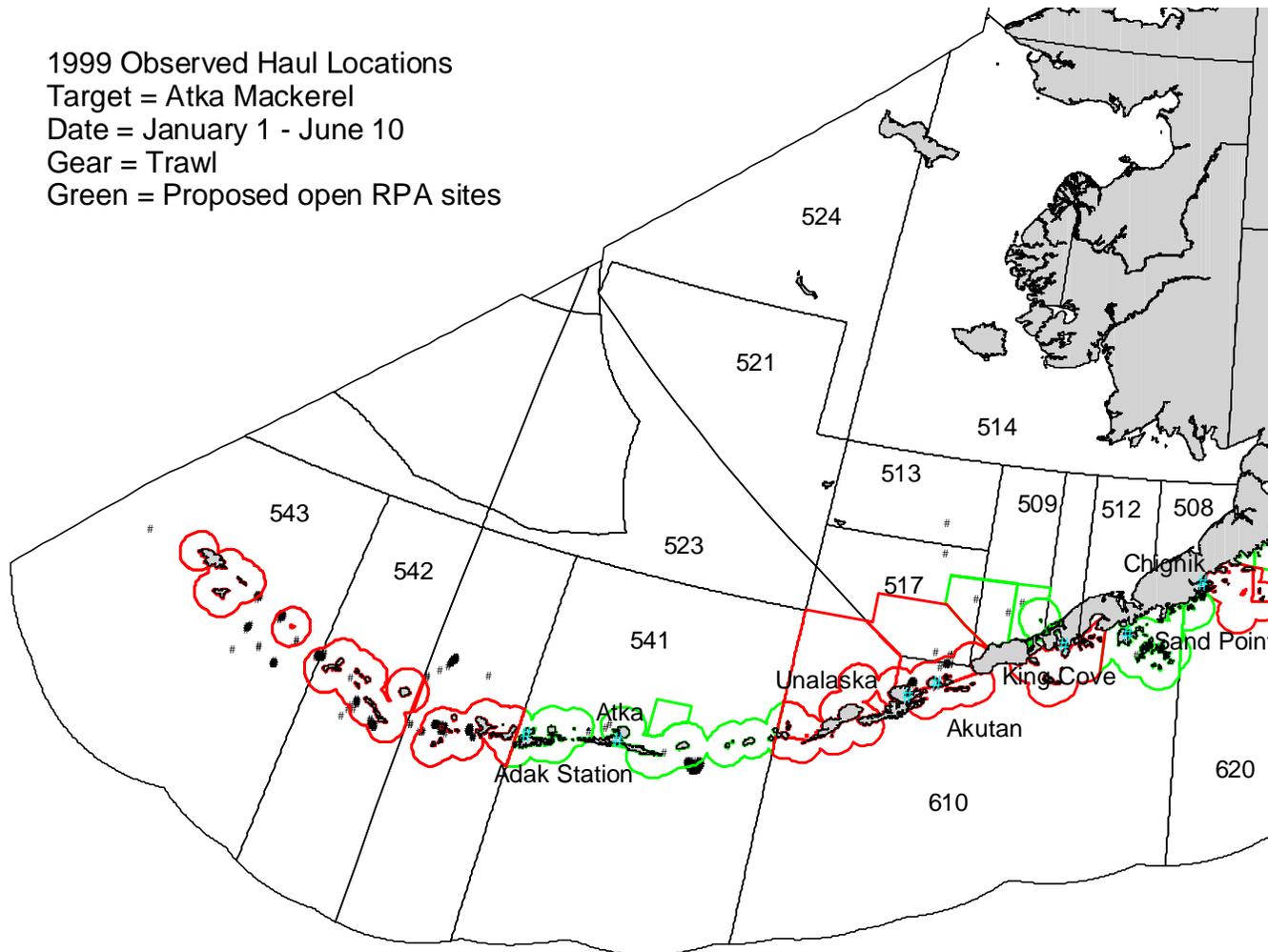
Black and white version of the previous figure.



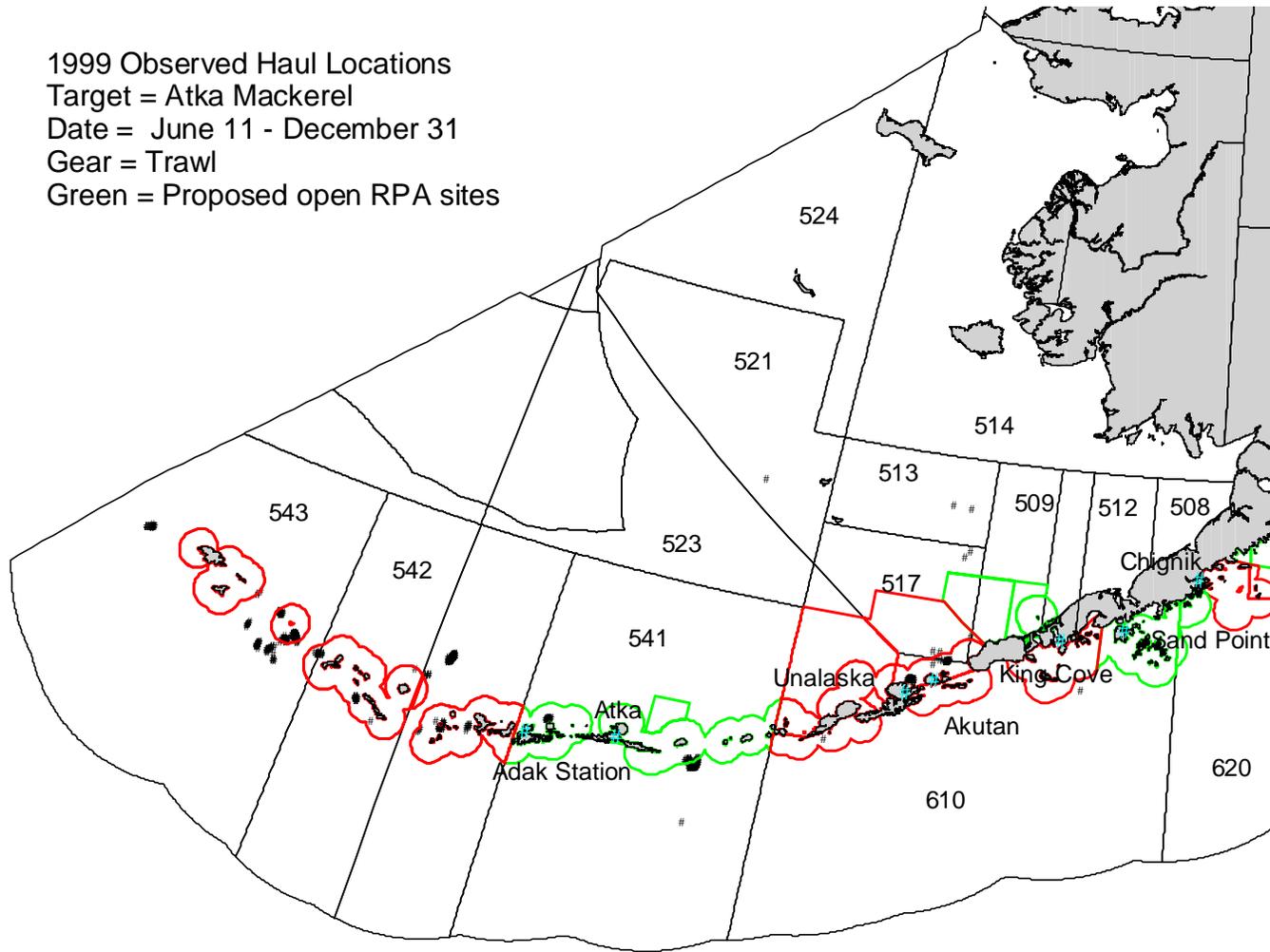
1999 Observed Haul Locations
Target = Pollock
Date = June 11 - December 31
Gear = Trawl
Green = Proposed open RPA sites



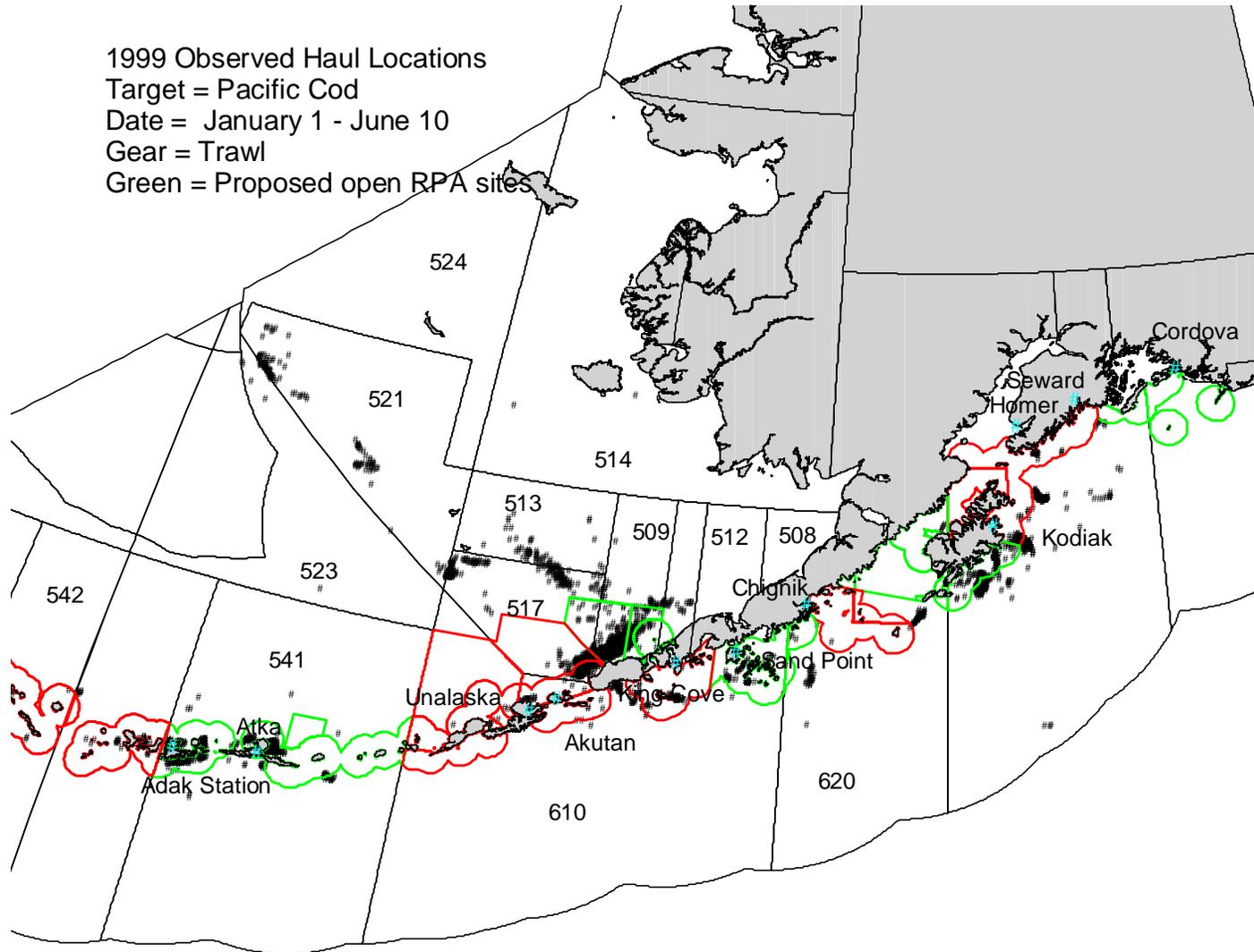
1999 Observed Haul Locations
Target = Atka Mackerel
Date = January 1 - June 10
Gear = Trawl
Green = Proposed open RPA sites



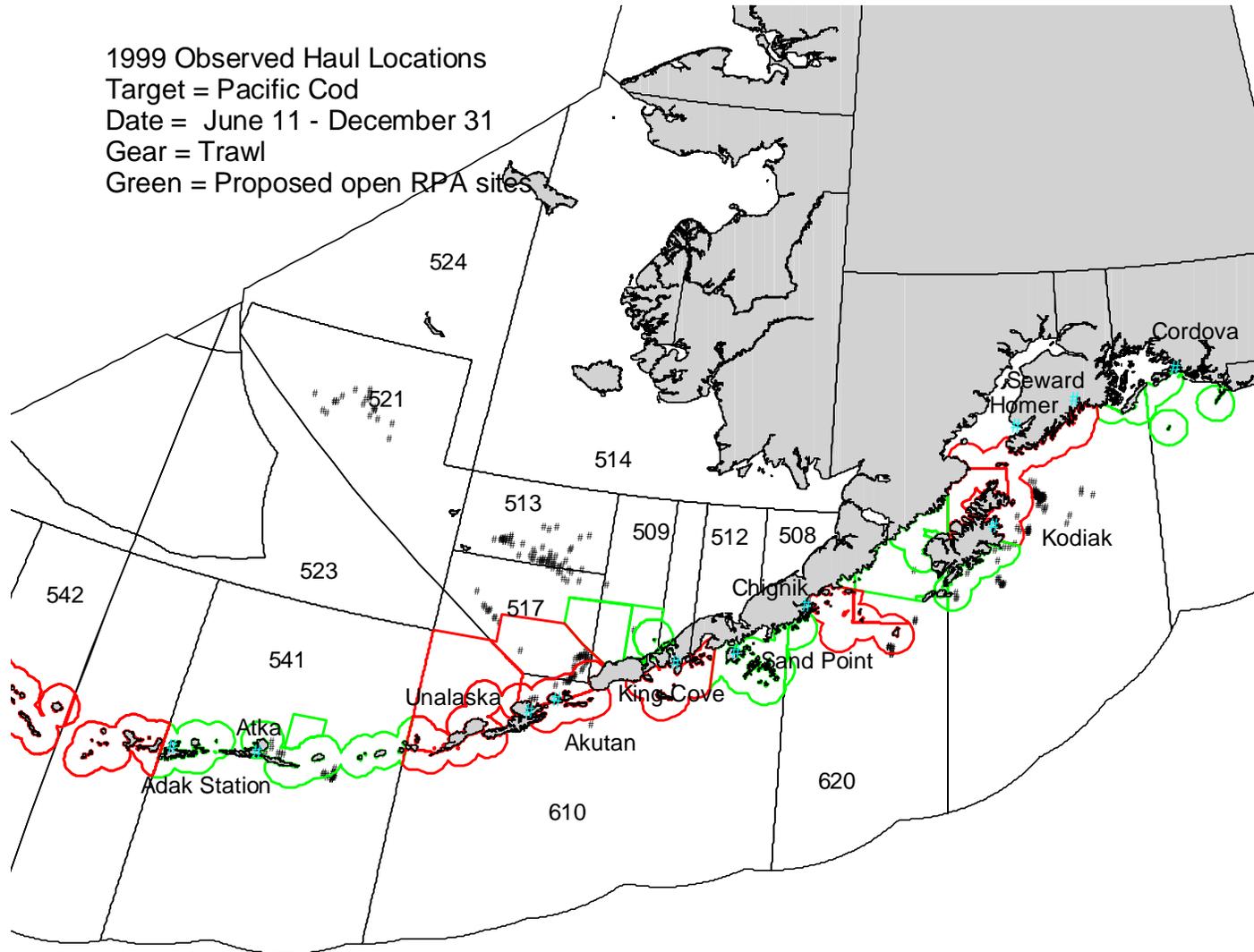
1999 Observed Haul Locations
Target = Atka Mackerel
Date = June 11 - December 31
Gear = Trawl
Green = Proposed open RPA sites



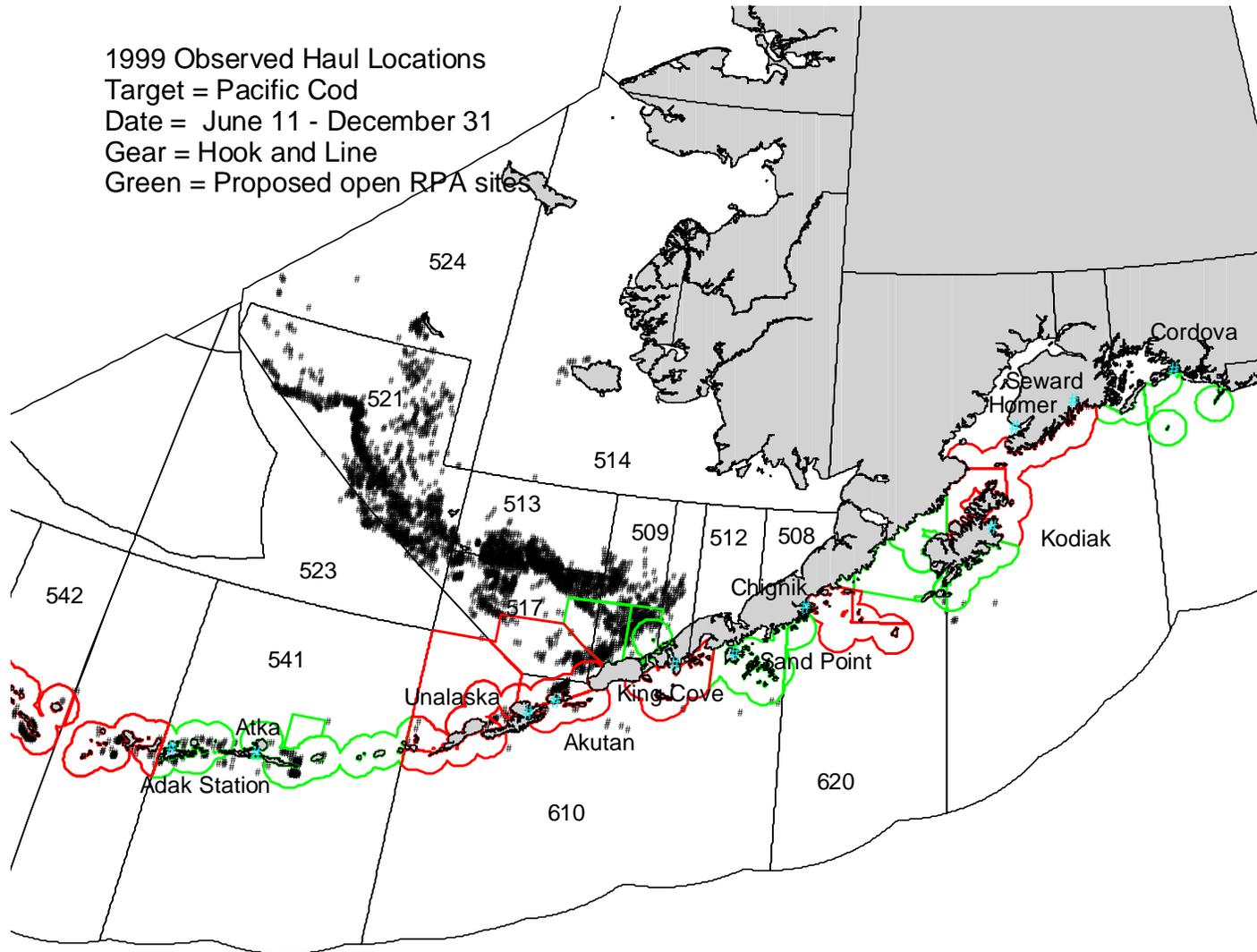
1999 Observed Haul Locations
Target = Pacific Cod
Date = January 1 - June 10
Gear = Trawl
Green = Proposed open RPA sites

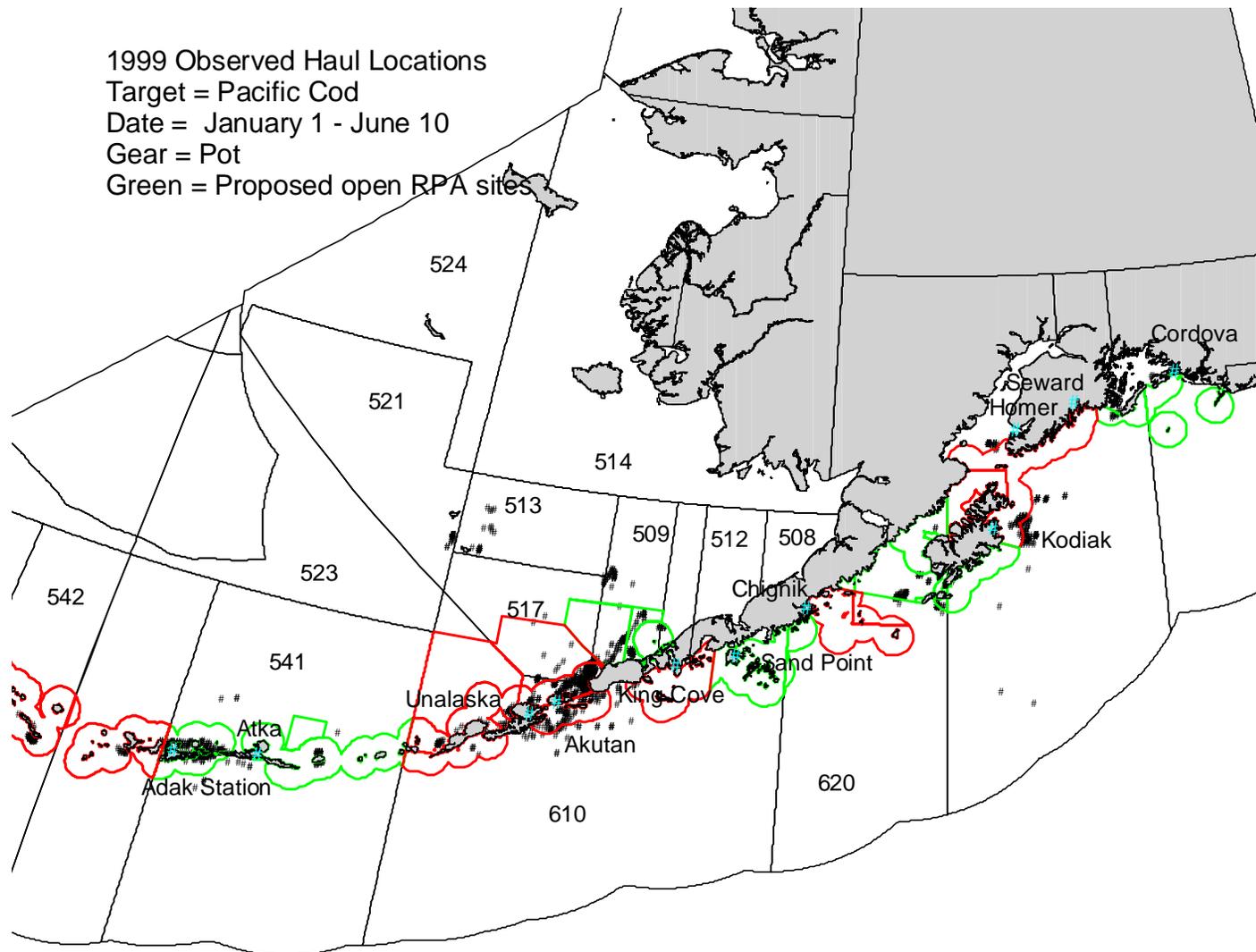


1999 Observed Haul Locations
Target = Pacific Cod
Date = June 11 - December 31
Gear = Trawl
Green = Proposed open RPA sites

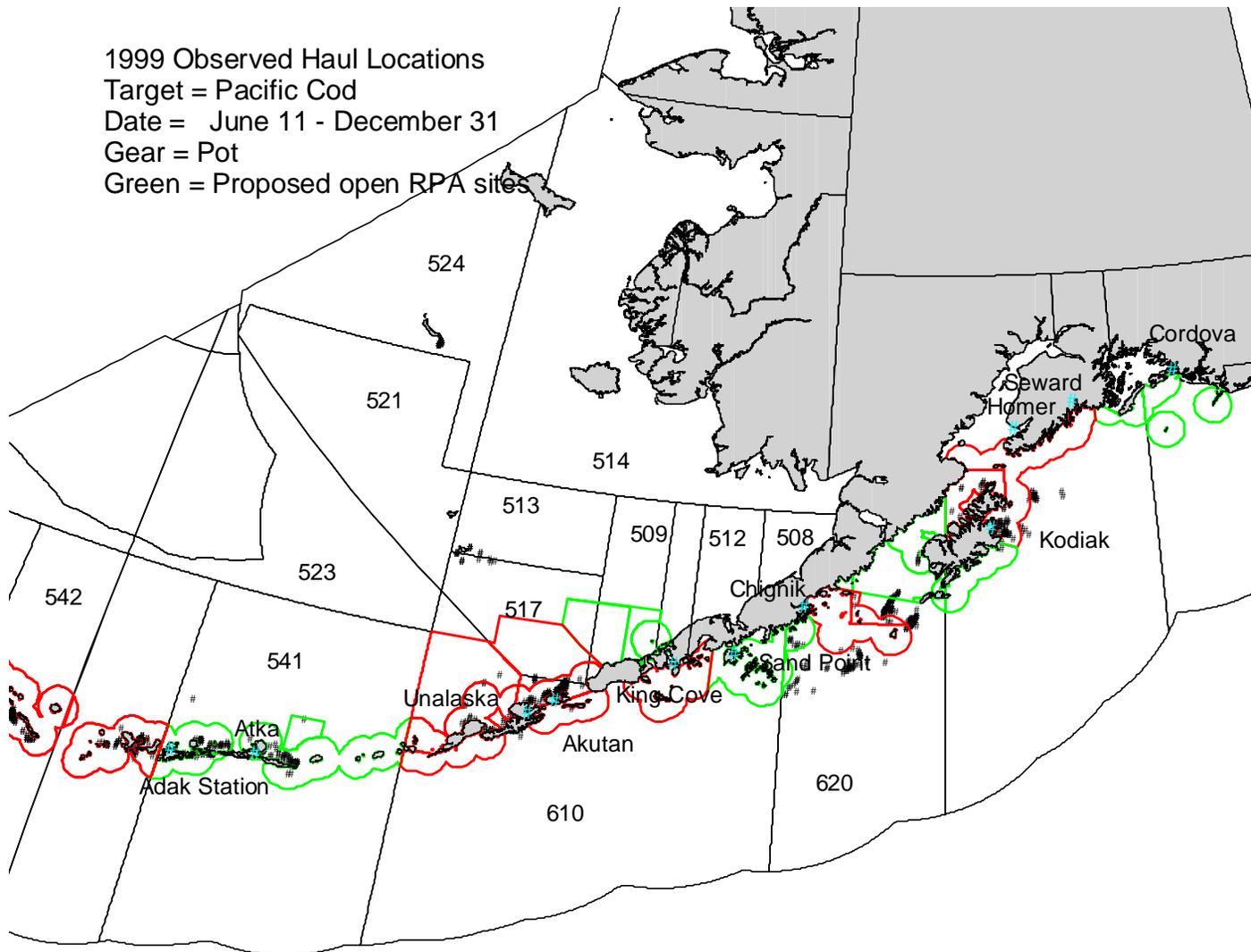


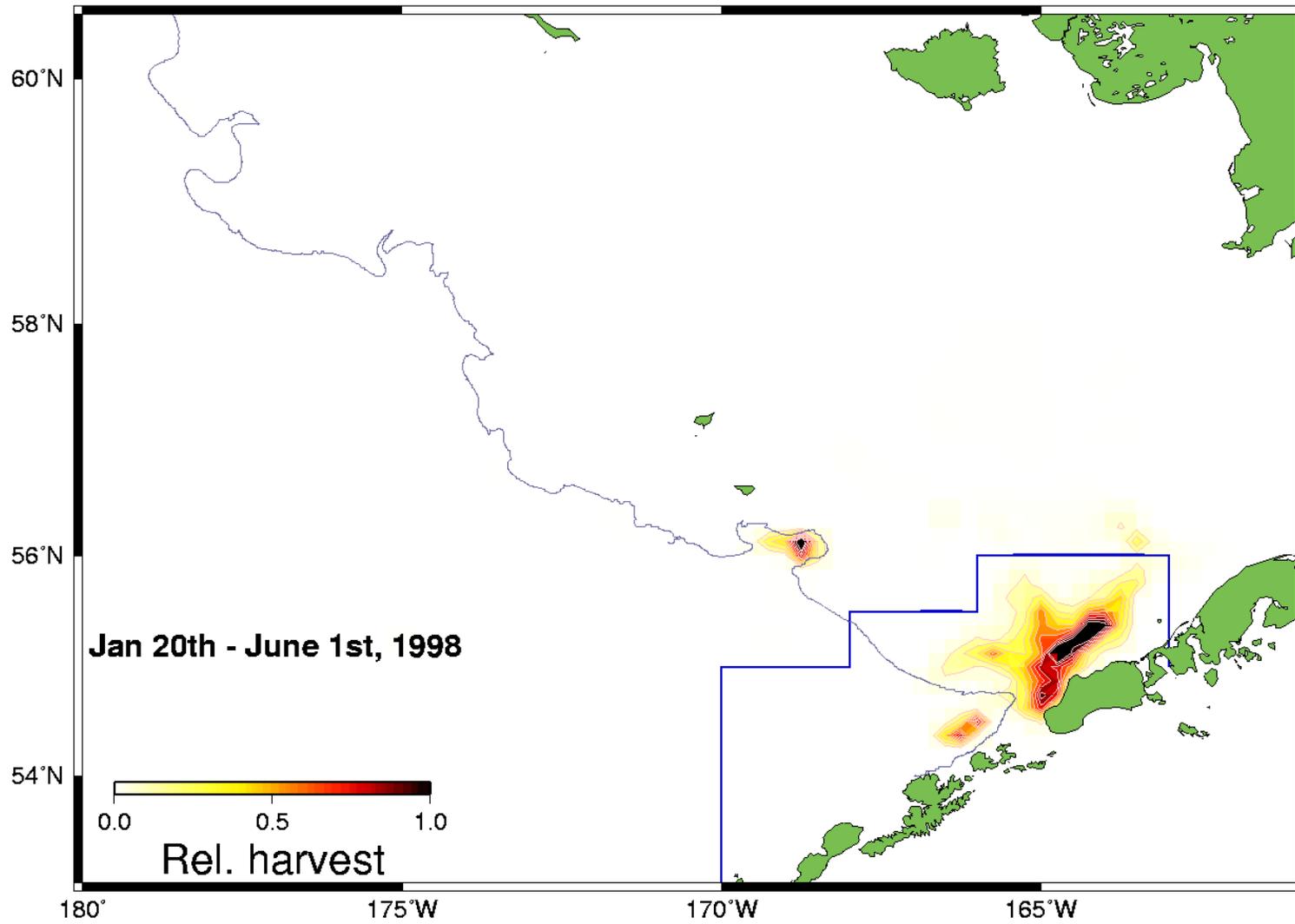
1999 Observed Haul Locations
Target = Pacific Cod
Date = June 11 - December 31
Gear = Hook and Line
Green = Proposed open RPA sites



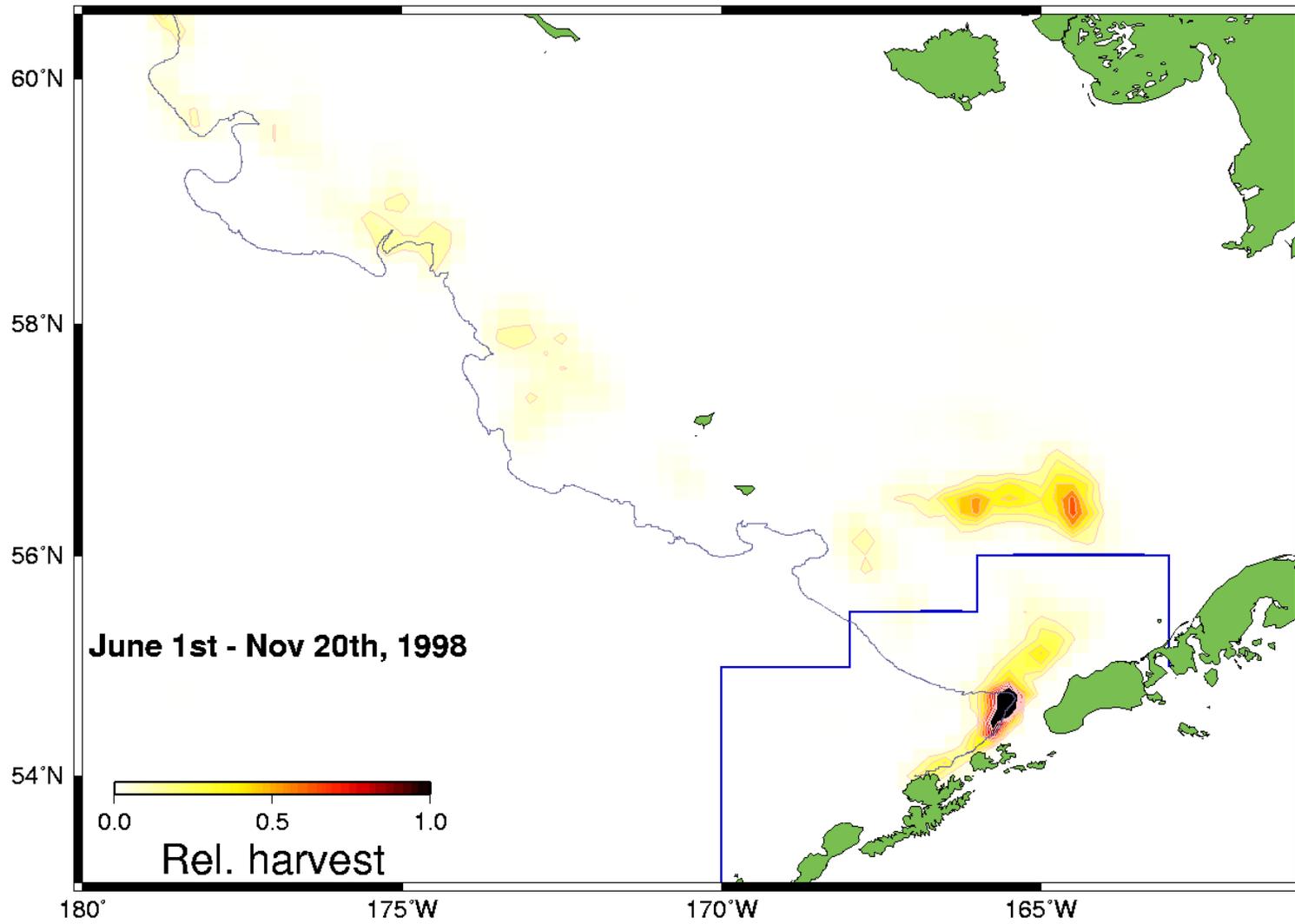


1999 Observed Haul Locations
Target = Pacific Cod
Date = June 11 - December 31
Gear = Pot
Green = Proposed open RPA sites

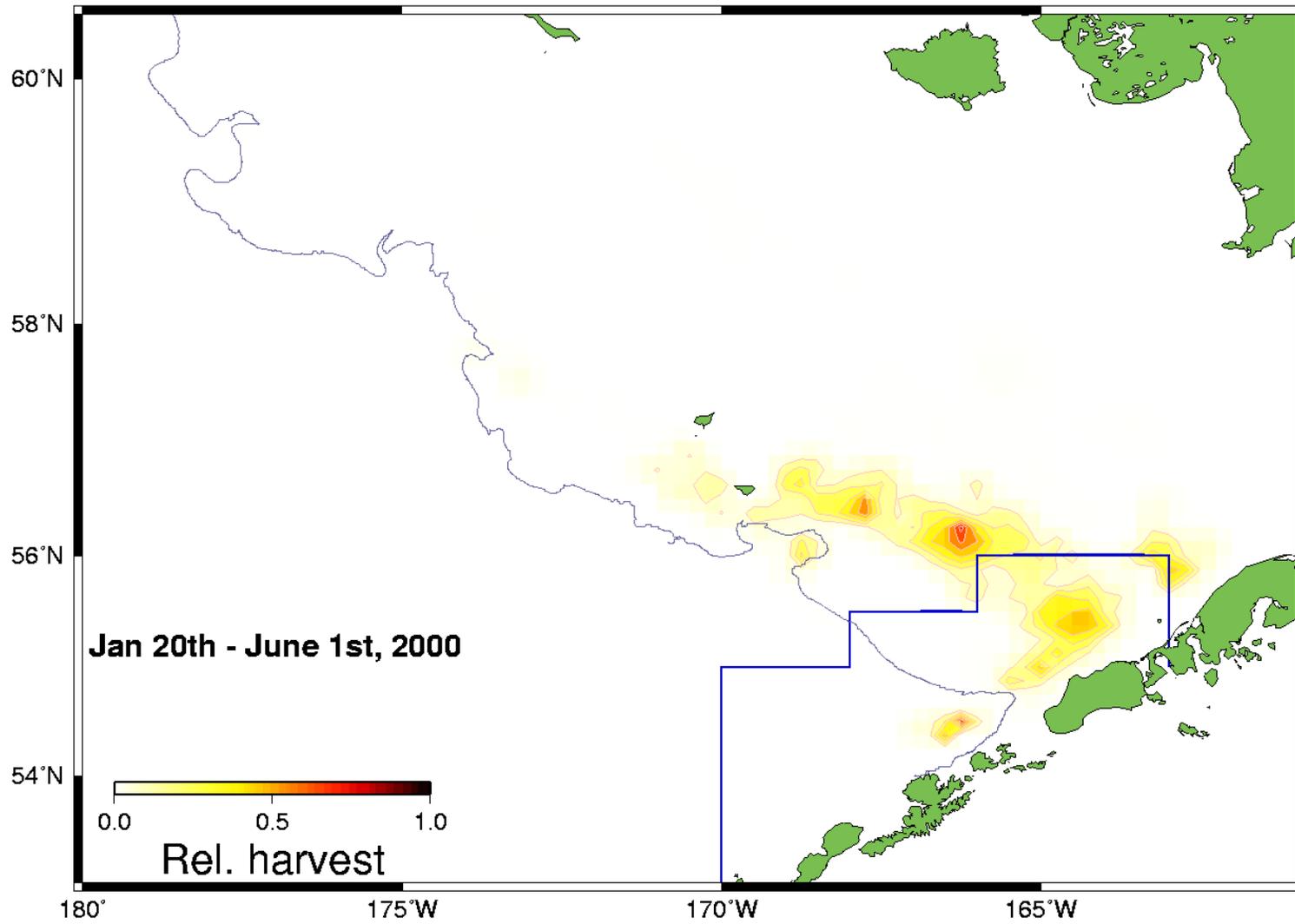




Relative harvest of pollock in the eastern Bering Sea, January 20th - June 1st, 1998.

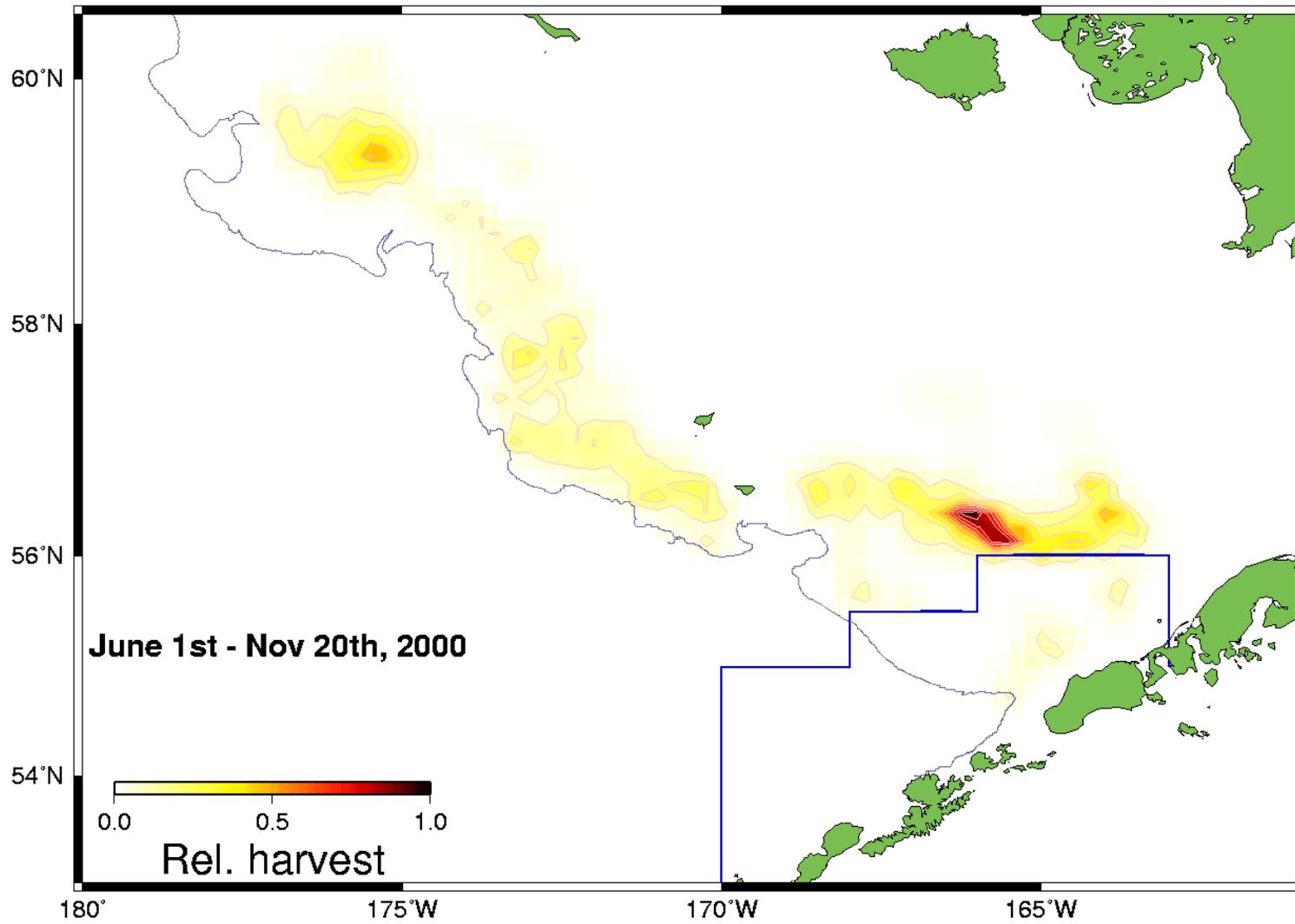


Relative harvest of pollock in the eastern Bering Sea, June 1st - November 20th, 1998.



November 30, 2000

Relative harvest of pollock in the eastern Bering Sea, January 20th - June 1st, 2000.



November 30, 2000

Relative harvest of pollock in the eastern Bering Sea, June 1st - November 20th, 2000.

Table 1.1. Consultation history on BSAI Groundfish Fishery Management Plan and GOA Groundfish Fishery Management Plans as they pertain to Steller sea lions and other protected species.

Region	Year	Date	Consultation	ACTION	CONCLUSION
BSAI					
	1999	23-Dec	Formal	2000 TAC and AFA	No jeopardy
	1998	22-Dec	Formal	1999 TAC	No jeopardy
	1998	3-Dec	Formal	1999 pollock, Atka mackerel fisheries	Jeopardy and adverse modification by pollock fishery
	1998	26-Feb	Informal	1998 TAC	Reinitiation not triggered
	1997	17-Jan	Informal	1997 TAC	No adverse affects not already considered, reinitiation not necessary
	1996	26-Jan	Formal	1996 TAC and BSAI FMP	No jeopardy
	1995	26-Sep	Informal	Effect of I/O (38/40) on SSL	No adverse affects not already considered, reinitiation not necessary
	1995	25-Aug	Informal	Amendments 38/40, other species	No adverse affects not already considered, reinitiation not necessary
	1995	3-Feb	Informal	1995 TAC	No adverse affects not already considered, reinitiation not necessary
	1994	2-Feb	Informal	1994 TAC	No adverse affects not already considered, reinitiation not necessary
	1993	28-Apr	Formal	Delay of pollock "B" season	No jeopardy
	1993	20-Jan	Informal	1993 TAC	No adverse affects not already considered, reinitiation not necessary
	1992	9-Oct	Informal	Amendments 20/25	No adverse affects not already considered, reinitiation not necessary
	1992	11-Jun	Informal	IFQ fishery	No adverse affects likely, therefore further consultation not required
	1992	4-Mar	Formal	Amendment 18 inshore/offshore	No jeopardy
	1992	21-Jan	Formal	1992 TAC	No jeopardy
	1991	22-Oct	Informal	Amendments 17/22 & 20/25	No adverse affects not already considered, reinitiation not necessary
	1991	19-Apr	Formal	BSAI FMP	No jeopardy
	1990	30-Oct	Formal	Bering Sea snail fishery	No jeopardy
	1990	24-Oct	Formal	BSAI crab FMP	No jeopardy
	1989	5-Jul	Formal	Issue of MMPA exemptions	No jeopardy
	1979	14-Dec	Formal	BSAI FMP	No jeopardy (only whales listed under ESA at this time)

Table 1.1 cont.

Region	Year	Date	Consultation	ACTION	CONCLUSION
GOA					
	1999	23-Dec	Formal	2000 TAC and AFA	No jeopardy
	1998	22-Dec	Formal	1999 TAC	No jeopardy
	1998	3-Dec	Formal	1999 pollock fishery	Jeopardy and adverse modification
	1998	2-Mar	Formal	1998 TAC	No jeopardy
	1997	10-Sep	Informal	Amendment 46	Action will not adversely affect listed species
	1997	17-Jan	Informal	1997 TACs	No adverse affects not already considered, reinitiation not necessary
	1996	26-Jan	Formal	1996 TAC and GOA FMP	No jeopardy
	1995	26-Sep	Informal	Effect of I/O (38/40) on SSL	No adverse affects not already considered, reinitiation not necessary
	1995	25-Aug	Informal	Amendments 38/40, other species	No adverse affects not already considered, reinitiation not necessary
	1995	3-Feb	Informal	1995 TAC	No adverse affects not already considered, reinitiation not necessary
	1994	31-Jan	Informal	1994 TAC	No adverse affects not already considered, reinitiation not necessary
	1993	6-Jul	Informal	Amendment 31	No adverse affects not already considered, reinitiation not necessary
	1993	16-Feb	Informal	Season 2nd quarter delay	No adverse affects not already considered, reinitiation not necessary
	1993	27-Jan	Informal	1993 TAC	No adverse affects not already considered, reinitiation not necessary
	1993	6-Jan	Informal	EFP	Action will not adversely affect listed species
	1992	11-Jun	Informal	IFQ fishery	No adverse affects likely, therefore further consultation not required
	1992	4-Mar	Informal	Season 2nd quarter delay	Action will not adversely affect listed species
	1991	23-Dec	Informal	1992 TAC	No adverse affects not already considered, reinitiation not necessary
	1991	12-Nov	Informal	Amendment 23	No adverse affects not already considered, reinitiation not necessary
	1991	22-Oct	Informal	Amendments 17/22 & 20/25	No adverse affects not already considered, reinitiation not necessary
	1991	20-Sep	Formal	4th quarter pollock fishery	No jeopardy
	1991	5-Jun	Formal	1991 pollock TAC	No jeopardy
	1991	19-Apr	Formal	GOA FMP	No jeopardy

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
1	<p>The amendment included the following measures:</p> <ol style="list-style-type: none"> 1. Established a multi-year, multi-species optimum yield for BSAI groundfish complex (1.4 million to 2.0 million mt); 2. Established a framework procedure for the determination and apportionment of amounts of groundfish specified for total allowable catch (TAC), domestic annual harvest (DAH), reserves, and total allowable level of foreign fishing (TALFF); 3. Allowed year-round domestic trawling and longlining in the Winter Halibut Savings Area and Bristol Bay Pot Sanctuary; 4. Modified seasonal foreign trawl restrictions in the Petrel Bank area to be based on crab opening dates; 5. Updated appendices and annexes to the FMP; added Annex I (description of SAFE document); and 6. Eliminated “Misty Moon” grounds south of the Pribilofs from the winter halibut savings area.
1a	<p>Amendment 1a established foreign chinook salmon PSC limits as follows: During any fishing year, that portion of fishing Area 1 lying between 55° N and 57°N latitude and 165° W and 170° W longitude and all of fishing Area 2 may be closed for the remainder of the periods January 1 through March 31, and October 1 through December 31 to trawl vessels of any nation. This closure will occur when vessels of a nation have intercepted that nation’s portion of the PSC of chinook salmon. A nation’s initial portion of the chinook salmon PSC for a fishing year was determined by multiplying 55,250 (the total PSC for chinook salmon) by the ratio of that nation’s initial groundfish allocation to the total initial TALFF plus reserves for groundfish.</p>
2	<p>The amendment changed the specifications for yellowfin sole, other flatfish, and Pacific cod as follows:</p> <p>Yellowfin sole: DAH increased from 2,050 mt to 26,200 mt. JVP increased from 850 mt to 25,000 mt. TALFF decreased by 24,150 mt.</p> <p>Other flatfish: DAH increased from 1,300 mt to 4,200 mt. JVP increased from 100 mt to 3,000 mt. TALFF decreased by 2,900 mt.</p> <p>Pacific cod: MSY decreased from 58,700 mt to 55,000 mt. EY increased from 58,700 to 160,000 mt. ABC increased from 58,700 mt to 160,000 mt. OY increased from 58,700 mt to 78,700 mt. Reserve increased from 2,935 mt to 3,935 mt. DAP increased from 7,000 mt to 26,000 mt. DAH increased from 24,265 mt to 43,265 mt.</p>
3	<p>Amendment 3 reduced bycatch of prohibited species in foreign groundfish fisheries. Essentially, total PSC allocations for (cont.) foreign nations were based on bycatch rates multiplied by the nations TALFF allocation. Bycatch rate reductions to be met by 1986 from status quo base years (1977-80) were as follows: halibut, 50%; king and Tanner crab 25%; salmon 75%. The target level of salmon bycatch</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	was 17,473 fish. If bycatch apportionments for any PSC species were met or exceeded, that nation’s fleet was prohibited from fishing in the entire BSAI area, unless exempted by the NMFS Regional Director.
4	<p>Amendment 4 allowed foreign trawling outside 3 miles north of the Aleutians between 170°30 W and 170°W and south of the Aleutians between 170°W and 172°W, and allowed foreign longlining outside 3 miles west of 170°W longitude. Amendment 4 also changed the specifications for yellowfin sole, other flatfish, and Pacific cod as follows:</p> <p>Pollock: DAH increased from 19,550 mt to 74,500 mt, JVP increased from 9,050 mt to 64,000 mt. TALFF decreased from 930,450 mt to 875,500 mt.</p> <p>Yellowfin sole: DAH increased from 26,200 mt to 31,200 mt, JVP increased from 25,000 mt to 30,000 mt. TALFF decreased from 84,950 mt to 79,950 mt.</p> <p>Other flatfish: DAH increased from 4,200 mt to 11,200 mt, JVP increased from 3,000 mt to 10,000 mt. TALFF decreased from 53,750 mt to 46,750 mt.</p> <p>Atka mackerel: DAH increased from 100 mt to 14,500 mt, JVP increased from 100 mt to 14,500 mt TALFF decreased from 23,460 mt to 9,060 mt.</p> <p>Other species: DAH increased from 2,000 mt to 7,800 mt, JVP increased from 200 mt to 6,000 mt. TALFF decreased from 68,537 mt to 65,648 mt. ABC corrected to be 79,714 mt, OY to 77,314 mt, and reserves to 3,566 mt.</p> <p>Other rockfish: DAP set at 1,100 mt for BSAI area combined.</p> <p>POP: DAP set at 550 mt for Bering Sea and 550 mt for Aleutians. JVP set at 830 mt for Bering Sea and 830 mt for Aleutians.</p> <p>Sablefish: JVP set at 200 mt for Bering Sea and 200 mt for Aleutians. MSY set at 11,600 mt for Bering Sea and 1,900 mt for Aleutians.</p> <p>Pacific cod: EY and ABC increased from 160,000 mt to 168,000 mt, OY increased from 78,700 mt to 120,000 mt. Reserve increased from 3,935 mt to 6,000 mt, TALFF increased from 31,500 mt to 70,735 mt.</p>
5	The amendment was withdrawn when it was superceded by implementation of Amendment 3.
6	<p>Amendment 6 would have established a fishery development zone (FDZ). The proposed FDZ was located north and west of Unimak Pass and was bounded by the following coordinates:</p> <p>55°16' N Latitude, 166°10' W Longitude; (cont.) 54°00' N Latitude, 166°10' W Longitude; 54°35' N Latitude, 164°55'42" W Longitude;</p> <p>The FDZ would have been reserved for use by domestic fishing vessels – including those delivering to shore-based processors, U.S.</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	catcher/processors, and foreign processing vessels involved in U.S. joint venture operations. All foreign harvest operations would have been excluded year-round from the FDZ.
7	Amendment 7 allowed the foreign longline fleet to fish in the shallow waters of the WHSA so as to allow them to catch their allocation of Pacific cod. However, the depth restriction would be reimposed if the foreign longline fleet in the entire BSAI caught 105 metric tons of halibut as bycatch during the 12 month period of June 1 through May 31. Thus, if the incidental catch of Pacific halibut by foreign longline vessels in the BSAI reached 105 mt between June 1 and November 30, the WHSA would be closed to foreign longlining landward of the 500 meter depth contour for the 6-month period December 1 through May 31. If the incidental catch limit of 105 mt was reached from December 1 though May 31, the restriction would be reimposed for whatever remained of that 6-month period.
8	Amendments 3 and 8 reduced bycatch of prohibited species in foreign groundfish fisheries. Amendment 3 set a goal of total salmon bycatch of 17,473 fish by 1986, which was a 75% reduction from the 1981 salmon PSC of 69,893 and a 78% reduction from the average salmon bycatch of 80,000 fish for the years 1977-80. Amendment 8 implemented a salmon PSC limit of 38,441 fish for 1984 and 27,957 fish for 1985. The 1986 limit remained at the 17,473 fish PSC envisioned in Amendment 3.
9	<p>Three parts of Amendment 9 were approved:</p> <ul style="list-style-type: none"> (7) incorporate catcher/processor and mothership vessel reporting requirements to provide NMFS with more timely catch information necessary for adequate in-season management (weekly processor report with check-in/check-out reporting). A reporting system for catch held aboard for 14 days or more by the expanding domestic fleet was established. Permit holders must identify vessels as: (a) harvesting/processing, (b) mothership processing; (c) harvesting only; or (d) support only. (8) incorporate the NMFS habitat protection policy into the FMP in response to NMFS' Habitat Conservation Policy which advocates consideration of habitat concerns in developing or amending FMPs; and (9) incorporate a definition of directed fishing. <p>One action associated with habitat consideration in the FMP, to prohibit the discard of fishing gear and marine debris, was reserved until the required analysis was prepared. A measure to reduce bycatch of fully utilized species by closing an area within 20 miles of the Aleutian Islands to foreign trawling was disapproved.</p>
10	<p>The final regulations contained the following four parts: (cont.)</p> <ul style="list-style-type: none"> 1) Closed the area north of the Alaska Peninsula, south of 58° N. latitude, west of 160° W longitude, and east of 162° W longitude to all trawling year-round and established the following PSC limits and bycatch limitation zones: Applicable to all domestic vessels in directed fisheries for yellowfin sole and other flatfish in the specified zone: <ul style="list-style-type: none"> a) 80,000 <i>C. bairdi</i> in bycatch limitation Zone 1 b) 135,000 red king crab in Zone 1 c) 326,000 <i>C. bairdi</i> in Zone 2; Applicable to foreign directed fishing for yellowfin sole and other flatfish: 64,000 <i>C. bairdi</i> in Zones 1 and 2 combined;

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>Applicable to domestic vessels in directed fisheries for yellowfin sole and other flatfish and delivering to foreign processing vessels (i.e. joint ventures): 828,000 halibut in the entire BSAI.</p> <ol style="list-style-type: none"> 2) Required written weekly catch reports from all catcher/processers and motherships regardless of when the catch is landed (BSAI Amendment 9 implemented the same requirement for catcher/processers holding their catch for more than 2 weeks); 3) Provided authority to the Secretary to make inseason changes to gear regulations, season, and harvest quotas; and 4) Provided the Secretary with inseason authority to reapportion surplus groundfish within the domestic allowable harvest.
11	<p>The regulations implemented the following three provisions:</p> <ol style="list-style-type: none"> 1) Established an apportionment of the pollock TAC allocated to joint venture operations of 40% in the first season (January 1-April 15) and 60% in the second season (April 16-December 31). The measure was effective only in 1988 and 1989; 2) Revised the definition of acceptable biological catch (ABC) to conform with that used by the Pacific Council and includes definitions for “threshold” and “overfishing;” 3) Revised the definition of prohibited species to specifically name the species to be prohibited in the catches of foreign and domestic fishermen. Steelhead and Pacific salmon were added to the prohibited species list of halibut, herring, and king and Tanner crab for domestic and foreign fisheries; all salmonids are prohibited for foreign fishermen. <p>The final rule for Amendment 11 also clarified that the definition of directed fishing (20% or more of the harvest) applied to domestic fisheries as well as foreign fisheries. This was inadvertently omitted from the proposed and final rule for BSAI Amendment 10.</p>
11a	<p>The regulations implemented the following provisions to the BSAI FMP:</p> <ol style="list-style-type: none"> 1) Augmented the current catcher/processor and mothership reporting requirements with at-sea transfer information, specifically, a Cargo Transfer/Off-Loading Log and Product Transfer Report; 2) Revised the definition of prohibited species to include Pacific salmonids, Pacific herring, Pacific halibut, king crab, Tanner crab, and steelhead trout. Respecified the other three categories: (cont.) <ol style="list-style-type: none"> a) Target species–pollock, Pacific cod, flounders, rockfish, and sablefish b) Other species–Atka mackerel, squid, sculpins, sharks, skates, eulachon, smelts, capelin, and octopus c) Non-specified species–those species taken incidentally in the groundfish fisheries but are not managed by the FMP. No catch records are required; 3) Required the public comment period for proposed annual specifications and prohibited species catch limits to be 30 days following the date of filing of the notice for public inspection with the Office of the Federal Register.
12	<p>Amendment 12 required:</p> <ol style="list-style-type: none"> (1) All vessels receiving groundfish harvested in the EEZ to hold a federal permit and comply with federal reporting requirements;

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>(2) established PSC limit framework for groundfish species in the joint venture and foreign fisheries;</p> <p>(3) established rock sole as a target species separate from the “other flatfish” category;</p> <p>(4) removed the July 1 deadline for resource assessment document.</p>
12a	<p>The PSC limits set in regulation under Amendment 12a are listed at right.</p>
13	<p>Amendment 13 to the groundfish FMPs authorized a comprehensive domestic fishery observer program. The 1990 and 1991 Observer Plans required specific levels of observer coverage which varied with size of fishing vessel and quantity of fish processed.</p> <p>The Observer Plans required that owners and operators of vessels and shoreside processing facilities participating in the groundfish fishery arrange for and pay for the cost of placing observers aboard their vessels and at their shoreside processing facilities beginning in January 1990. Each vessel or processor required to have observer coverage is responsible for the cost of obtaining the required observers from a certified contractor.</p> <p>Amendment 13 also:</p> <ul style="list-style-type: none"> (1) allocated sablefish: 50/50 percent to fixed and trawl gear in the BS and 75/25 percent to fixed and trawl gear in the AI; (2) closed waters seaward of 3 miles out to 12 miles surrounding the Walrus Islands (Round Island and the Twins) and Cape Peirce from April 1 through September 30 to groundfish fishing; (3) deleted fishing season dates from the FMPs but retained them in regulation; (4) clarified authority to recommend TACs for additional or fewer target species within the “target species” category.
14	<p>The amendment implemented rules that regulated the practice of stripping roe (eggs) from female pollock and discarding female and male pollock carcasses without further processing, and seasonally allocated the TAC of pollock. Season opening dates were established as follows for the GOA: January 1, April, July, and October, and for the BSAI: January 1 and June 1. To get at the issue of roe stripping, product recovery rate standards were established, which if exceeded would constitute a violation. The recovery rate (cont.) standard established was 10 percent of the total round-weight equivalent of pollock and other pollock products onboard a vessel at any time during a fishing trip. To extrapolate round weight equivalents, the rule established product recovery rates as follows: fillet (18%), surimi (15%), mince (17%), meal (17%), and head & gut (50%).</p>
15	<p>The IFQ Program was approved for the Pacific halibut and sablefish fixed gear fisheries in the Federal waters of the BSAI and GOA, and these fisheries have been managed under the program since 1995. The regulations outline several key provisions of the program: initial allocation of quota shares; vessel categories; transfer provisions; use and ownership provisions; the annual process for allocating quota shares (QS); and the establishment of Community Development Quotas. The regulations state that legal landings of halibut or sablefish harvested with fixed gear had to occur at any time during 1988-1990 to qualify for an initial allocation of quota share. Generally, if a vessel owner or lessee is qualified, their initial quota share would be based on their highest total landing of halibut for any 5 years of the 7-year base period 1984-1990. For sablefish, the initial quota share would be based on the highest total landing of sablefish for any 5 years of the 6-year base period 1985-1990. Each person eligible to receive quota share would have it assigned to one of four vessel</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>categories: “A”-freezer vessels of any length; “B”- catcher vessels greater than 60'; “C”- catcher vessels less than or equal to 60' for sablefish, or between 35'-60' for halibut; “D”- catcher vessels less than or equal to 35' for halibut. Initial quota share would be assigned to the vessel category that a person’s most recent fixed gear landings of groundfish or halibut were caught by that vessel. Various restrictions on transfer and ownership are designed to maintain the owner/operator characteristics of the fleet, and to prevent consolidation of QS in the hands of a few participants.</p>
16	<p>The Amendment contained 8 approved management measures as follows:</p> <ol style="list-style-type: none"> 1. Modified PSC limits and bycatch limitation zones for halibut, bairdi crab, and red king crab in the BSAI; 2. Apportioned PSC limits into bycatch allowances for trawl fishery categories; 3. Allowed separate apportionment of halibut PSC to hook and line and pot gear in the GOA; 4. Allowed seasonal allocation of halibut and crab PSC; 5. Established procedures for interim TAC specifications 6. Established fishing gear restrictions (definition of pelagic trawl, biodegradable panels & halibut excluders on pot gear); 7. Modified authorization language that allows demersal shelf rockfish in SE Alaska to be managed by the State; and 8. Established definitions of overfishing. <p>Later revisions to the amendment included addition of a vessel incentive program, which would issue civil penalties (fines) to vessels that exceeded seasonal fixed bycatch rate standards for halibut and crab taken in specified target fisheries.</p>
16a	<p>Amendment 16a established prohibited species bycatch limits for Pacific herring taken as bycatch in trawl fisheries. The annual PSC limit was set at 1% of the annual biomass of eastern Bering Sea herring, and is apportioned among trawl fishery categories. Attainment of any apportionment triggers closure of herring savings areas to that fishery. The Herring Savings Areas are described as (cont.)</p> <p>follows:</p> <ol style="list-style-type: none"> (1) Summer Herring Savings Area 1 means the part of the Bering Sea subarea that is south of 57° N. latitude and between 162° and 164° W longitude from 12:00 noon Alaska Local Time (ALT) June 15 through 12:00 noon ALT July 1 of a fishing year. (2) Summer Herring Savings Area 2 means the part of the Bering Sea subarea that is south of 56°30' N. latitude and between 164° and 167° W. longitude from 12:00 noon ALT July 1 through 12:00 noon ALT August 15 of a fishing year. (3) Winter Herring Savings Area means that part of the Bering Sea subarea that is between 58° and 60° N. latitudes and between 172° and 175° W. longitudes from 12:00 noon ALT September 1 through 12:00 noon ALT March 1 of the succeeding fishing year. <p>The Regional Director may promulgate an inseason closure of an area (for up to 60 days) to reduce prohibited species bycatch rates. A</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	number of factors must be considered when implementing any ‘hot spot’ closure. Also, Amendment 16a allows the Regional Director, in consultation with the Council, to limit the amount of pollock that may be taken with trawls other than pelagic trawls. The Council's recommendations are to be available to the public for comment under the annual TAC specification process.
17	Amendment 17 prohibits all vessels federally permitted to fish for groundfish from entering the walrus haulout closure areas from April 1 through September 30. These areas include the EEZ within 12 miles of islands named Round Island and The Twins, and around Cape Peirce. Amendment 17 allows the NMFS Regional Director, after consulting with the Director of the Alaska Fishery Science Center and with the Council, to authorize for limited experimental purposes, the target or incidental harvest of groundfish that would otherwise be prohibited. The amendment also combined statistical area 68 with statistical area 65, established the Bogoslof Area, and requires pot gear to be identified as such when groundfish fishing.
18	The alternative adopted and approved defined the inshore and offshore components of the fisheries. BSAI Amendment 18 was only partially approved, allocating 35% of the 1992 non-roe pollock season TAC to the inshore component, and the remaining 65% to the offshore component. The portion that was not approved would have further allocated pollock through 1995: (the inshore allocation would have increased to 40% in 1993 and 45% in both 1994 and 1995). A NMFS economic review indicating a large net loss to the Nation as a result of this action provided the rationale for disapproval by the Secretary of Commerce. (Analysis of adjoining GOA Amendment 23 indicated a net benefit; therefore, that amendment was approved in full. The GOA inshore component was allocated 90% of the Pacific cod TAC and 100% of the pollock TAC for each fishing year.) While catcher/processors from the offshore component would not be able to conduct directed pollock fishing in the GOA, they would be allowed appropriate bycatch amounts. Amendment 18 also established the CVOA south of 56° N. latitude and between 163° and 168° W. longitudes and the Community Development Quota program. As a result of the CDQ program, 7.5 percent of the BSAI pollock TAC was reserved for CDQ (cont.) fisheries (a nonspecific reserve) at the beginning of the year, and that amount would be reduced as allocations are made to community development projects.
19	<p>Amendments 19/24 established three FMP amendment management measures. These are as follows: 1) For 1992, reduce the Pacific halibut prohibited species catch (PSC) limit established for BSAI trawl gear from 5,333 metric tons (mt) to 5,033 mt, but retain the primary halibut PSC limit at 4,400 mt; 2) For 1992, establish a 750 mt Pacific halibut bycatch mortality limit for BSAI fixed gear; and 3) Establish FMP authority to develop and implement regulatory amendments that allow for time/area closures to reduce prohibited species bycatch rates (revised “hotspot authority”). In addition to the above FMP amendments, the following amendments to current regulations were adopted:</p> <ul style="list-style-type: none"> (1) Revise BSAI fishery definitions for purposes of monitoring fishery specific bycatch allowances and assigning vessels to fisheries for purposes of the vessel incentive program; (2) Revise the management of BSAI trawl fishery categories for PSC accounting; (3) Expand the vessel incentive program to address halibut bycatch rates in all trawl fisheries; (4) Delay the season opening date of the BSAI and GOA groundfish trawl fisheries to January 20 of each fishing year to reduce salmon

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>and halibut bycatch rates; (5) Further delay the season opening date of the GOA trawl rockfish fishery to the Monday closest to July 1 to reduce halibut and chinook salmon bycatch rates; and (6) Change directed fishing standards to further limit halibut bycatch associated with bottom trawl fisheries.</p>
20	<p>Regulations authorized by Amendment 20 implemented the following measures:</p> <ol style="list-style-type: none"> 5) Areas are closed year-round to fishing by vessels using trawl gear within 10 nautical miles of key Steller sea lion rookeries located in the GOA and BSAI management areas. 6) Areas are closed within 20 nm of five sea lion rookeries to directed pollock fisheries during the “A” season. These rookeries are Sea Lion Rocks, Akun Island, Akutan Island, Seguam Island, and Agligadak Island 7) In the GOA, the specified total allowable catch for pollock in the combined western/central area is further divided among three pollock management districts: Area 61 (170°-159° W. longitudes), Area 62 (159°-154° W. longitudes), and Area 63 (154°-147° W. longitudes). The Shelikof Strait district was eliminated. To prevent excessive accumulation of unharvested portions in any quarterly allowance of the pollock TAC, a limit of 150 percent of the initial quarterly allowance in each pollock management district was established.
21	<p>Amendment 21 implemented the following measures:</p> <ol style="list-style-type: none"> 1. Establish halibut bycatch limits in terms of halibut mortality rather than halibut bycatch; 2. Establish halibut bycatch mortality limits for trawl and non trawl fisheries in regulations rather than in the FMP to allow (cont.) for changes in bycatch mortality limits through a regulatory amendment process rather than an FMP amendment; and 3. Establish FMP authority to annually apportion the non-trawl halibut bycatch mortality limit among fisheries and seasons as bycatch allowances. This authority would be similar to FMP provisions for annual specification of bycatch allowances of prohibited species catch limits among trawl fisheries. <p>Consistent with this amendment, regulations established a 3,775 mt halibut bycatch mortality limit for trawl gear fisheries and a 900 mt halibut bycatch mortality limit for non-trawl fisheries.</p>
21a	<p>All trawling is prohibited at all times in the EEZ within the area bounded by a straight line connecting the following pairs of coordinates in the following order:</p> <p>(57° 57.0', 168° 30.0') (56° 55.2', 168° 30.0') (56° 48.0', 169° 2.4') (56° 34.2', 169° 2.4') (56° 30.0', 169° 25.2') (56° 30.0', 169° 44.1')</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>(56° 55.8', 170° 21.6')</p> <p>(57° 13.8', 171° 0.0')</p> <p>(57° 57.0', 171° 0.0')</p> <p>(57° 57.0', 168° 30.0')</p>
21b	<p>Amendment 21b established measures to control the amount of chinook salmon taken as bycatch in BSAI trawl fisheries. Specifically, the alternative adopted would close three areas in the BSAI to all trawling when 48,000 chinook salmon were taken as bycatch. The chinook salmon savings areas are shown in the adjacent figure. A closure will remain in effect from the time the trigger is reached until April 16, when the areas would reopen to trawling for the remainder of the year.</p>
22	<p>Amendment 22 allows the Secretary to promulgate regulations establishing areas where specific types of fishing gear may be tested, to be available for use when the fishing grounds are closed to that gear type. Specific gear test areas contained in regulations that implement the FMP were allowed by regulatory amendment. These gear test areas would be established in order to provide fishermen the opportunity to ensure that their gear is in proper working order prior to a directed fishery opening. The test areas must conform to the following conditions:</p> <ol style="list-style-type: none"> (1) Depth and bottom type must be suitable for testing the particular gear type. (cont.) (2) Must be outside State waters. (3) Must be in areas not normally closed to fishing with that gear type. (4) Must be in areas that are not usually fished heavily by that gear type. (5) Must not be within a designated Steller sea lion protection area at any time of the year. <p>The rule implementing this amendment established three trawl test areas: Dutch Harbor (54 °40' to 55° 00' N; 166° 00' to 167° 00' W), Sand Point (54 °35' to 54° 50' N; 160° 30' to 161° 00' W), and Kodiak (57 °23' to 57° 37'N; 151° 25' to 152° 02'W). The regulation further required that the trawl cod end must be left unzipped so as not to retain fish, that groundfish may not be onboard, and that the time used to test gear would not contribute to observer coverage requirements.</p>
23	<p>After several proposed moratoriums, the final rule required a moratorium permit for vessels within specific vessel categories that harvest groundfish and BSAI crab resources off Alaska. Generally, a vessel qualified for a moratorium permit if it made a legal landing of any moratorium species during the qualifying period of January 1, 1988 through February 9, 1992. In addition, a vessel that made a legal landing during the qualifying period, in either a groundfish or crab fishery, but not both, can cross over as a new vessel in the fishery in which it did not made a legal landing in the qualifying period provided: 1) it uses the same gear type in the new fishery as it used to qualify for the moratorium in the other fishery; or 2) it made a legal landing in the crossover fishery during the qualifying period and it uses only the same gear type it used in that period.</p>
24	<p>Amendment 24 was proposed to authorize the explicit allocation of BSAI Pacific cod among vessels using trawl, hook-and-line or pot</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	gear, and jig gear through 1996. The alternative adopted and approved allocated the BSAI Pacific cod TAC to the jig gear (2%), hook-and-line or pot gear (44%) and trawl gear (54%) fleets. The action also authorized the seasonal apportionment of the Pacific cod TAC for hook-and-line and pot gear, creating three four-month seasons. In addition, the regulation allowed for the reallocation of Pacific cod from the trawl sector to the longline and pot sectors, and vice versa, if NMFS determines that one gear group or the other will not be able to harvest its full allocation.
25	The alternative adopted and approved eliminated the primary PSC limit, but did not affect the overall halibut bycatch mortality limit (3,775 mt) for the BSAI trawl fisheries. The action also implemented regulatory amendments which 1) prohibited discards of salmon taken as bycatch in the BSAI groundfish trawl fisheries until a NMFS-certified observer determines the number of salmon and collects any necessary data; and 2) established the authority to release to the public vessel-specific observer data on bycatch of prohibited species in the BSAI and GOA groundfish fisheries.
26	The Salmon Donation Program authorizes the distribution of Pacific Salmon taken as bycatch in the groundfish trawl fisheries in the groundfish fisheries off Alaska to economically disadvantaged individuals through NMFS authorized distributor selected by the Regional Director in accordance with federal regulations implemented under the FMP.
27	The Magnuson-Stevens Act authorized the Council and the Secretary to establish a North Pacific Fisheries Research Plan which: (1) requires that observers be stationed on fishing vessels and at fish processing facilities, and (2) establishes a system of fees to pay for the cost of implementing the research plan. The Research Plan, as adopted under this amendment, contained four objectives and elements that included observer employment and contracts, observer duties, data collection and transmission, annual determination of coverage levels by fishery, in-season changes to coverage levels, establishment of an observer oversight committee, coordination between the NMFS groundfish and ADF&G shellfish observer programs, a fee assessment (up to 2% of ex-vessel value of harvested fish), and details on fee collection and contingency plans in case of funding shortfalls.
28	Under Amendment 28, the Aleutian Islands region was split into three management districts at 177° W longitude and 177° E longitude. The eastern, central, and western AI districts are shown in the adjacent figure and are denoted as statistical areas 541, 542, and 543.
29	<p>The amendment was never adopted and the vessel incentive portion was never implemented. NMFS expressed reservations about obtaining statistically valid estimates of salmon bycatch amounts for use in enforcing a vessel incentive program. Additionally, there were concerns raised about establishing a haul by haul vessel incentive program because the possibility of a vessel randomly encountering large numbers of salmon in a single haul, as well as vessels that deliver unsorted cod ends to shoreside operations. In both cases, violators would be unable to take action to avoid a violation. Notwithstanding these issues, it was felt that significant staff resources would need to be shifted to monitor salmon bycatch, enforce, and prosecute salmon bycatch violators.</p> <p>Given the difficulties presented in establishing a regulatory solution to individual vessel bycatch accounting, amendment development was put on hold while industry representatives developed their own voluntary program named the Salmon Foundation. Participants</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	assessed themselves a \$20 fee per chinook and raised a total of \$120,000 in 1994. The purpose of the Foundation was to use income generated from salmon bycatch assessment payments to develop a salmon bycatch avoidance program for the BSAI trawl fisheries and to fund research on stock origin of salmon taken as bycatch. After the Council adopted the time area closures in April 1995, the industry stopped the bycatch assessment fees, so the research monies were spent and the Foundation dissolved.
30	The alternative adopted and approved raised the sablefish Community Development Quota allocation limit for qualified applicants from 12% to 33% in order to allow total allocation of the sablefish CDQ reserve; removed the inadvertent inclusion of the CDQ program in the FMP for the GOA; and expanded the types of evidence that may be used to verify vessel leases for the halibut and sablefish individual fishing quota program. It was emphasized that this action did not change the amount of sablefish available for harvest by persons participating in the Pacific halibut and sablefish IFQ program.
31	The Modified Block Proposal provided that initial allocations of QS that represent less than 20,000 lb of IFQ in the implementation year will be issued as a block, 2) QS that represents 20,000 lb or more of IFQ in the implementation year will be “unblocked”, and 3) QS in a block cannot be separated and must be transferred as a block. Fishermen can own up to two blocks of halibut and two blocks of (cont.) sablefish QS in each area, but persons holding any amount of unblocked QS are limited to one block of QS per area. A sweep-up provision allowed fishermen to combine small amounts into fishable amounts: halibut blocks can be combined to a sum of less than 1,000 lbs and sablefish blocks can be combined until the sum reaches 3,000 lbs. The amendment also clarified that blocked and unblocked quota share would be transferable subject to the approval of the NMFS Regional Director. Because the Modified Block Proposal created the potential that some QS would become non-transferable because the size would exceed the quota share use limits established in prior regulations (50 CFR 676.22 (e)(f)); the alternative also allowed for the transfer of a quota share block exceeding the use limits by providing that one block could be divided into two blocks.
32	The amendment exempted some CDQ compensation QS from the block provision and allowed for a one year period of relief (one-time transfer) from the restriction against transferring CDQ compensation QS across vessel length categories. Regulations state that if a person is issued CDQ compensation QS for an area where the person already has regular QS, then their CDQ compensation QS is combined with their existing QS and is either “blocked” or “unblocked” depending on the sum total of their QS (this makes much of the CDQ compensation QS unidentifiable after issuance). If a person is issued CDQ compensation QS for an area in which the person doesn’t have other QS, the QS is left unblocked. The exemption does not include Category “A” vessels (vessels of any length authorized to process IFQ species).
33	The alternative adopted and approved authorized the processing of fish other than IFQ halibut or IFQ sablefish on board the harvesting vessel by persons authorized to harvest IFQ sablefish based on an annual allocation of IFQ assigned to vessel categories B or C. This authorization is not extended to persons authorized to harvest IFQ halibut, due to the fact that halibut is characteristically prosecuted by local vessels that do not have onboard processing capabilities. Several modifications were also made to the regulations implementing the IFQ program in order to accommodate the new provision. In addition, while non-IFQ species could be frozen onboard, the freezing of IFQ sablefish caught with catcher vessel quota share on a freezer vessel would continue to be prohibited.

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
34	<p>The Council adopted Amendment 34 to the FMP at its June 1997 meeting in response to concerns about the fast-paced nature of the Atka mackerel trawl fishery and the resulting preemption of the small-scale jig gear fishery. The Council's action would allocate up to 2 percent of the Atka mackerel TAC specified for the Eastern AI/BS to vessels using jig gear. The Council also voted to specify the jig gear allocation annually during the groundfish specifications process based on recent and anticipated harvests. This action was taken in consideration of the small amount of Atka mackerel annually harvested in recent years and to respond to trawl industry concerns about allocating more Atka mackerel to the jig gear fleet than could be harvested. Amendment 34 allowed for a ramp up provision, such that 1-percent of the Eastern AI/BS Atka mackerel TAC would be allocated to vessels using jig gear to begin the program. Once the jig gear fleet proved it could harvest that amount of TAC, the allocation could be increased to 2%.</p>
35	<p>Amendment 35 established measures to control the amount of chum salmon taken as bycatch in BSAI trawl fisheries. Specifically, the alternative adopted would close an area in the BSAI to all trawling from August 1 through August 31 (the time of year when (cont.) bycatch is highest). In addition, the area would remain closed or re-close after September 1, upon the attainment of a bycatch limit of 42,000 "other" salmon taken within the catcher vessel operational area (CVOA), through October 14. The chum salmon savings areas is the area bounded by a straight line connecting the following pairs of coordinates in the order listed:</p> <p style="padding-left: 40px;">56°00'N., 167°00'W.;</p> <p style="padding-left: 40px;">56°00'N., 165°00'W.;</p> <p style="padding-left: 40px;">55°30'N., 165°00'W.;</p> <p style="padding-left: 40px;">55°30'N., 164°00'W.;</p> <p style="padding-left: 40px;">55°00'N., 164°00'W.;</p> <p style="padding-left: 40px;">55°00'N., 167°00'W.;</p> <p style="padding-left: 40px;">56°00'N., 167°00'W.</p>
36	<p>Amendment 36 defined a forage fish species category and authorized that the management of this species category be specified in regulations in a manner that prevents the development of a commercial directed fishery for forage fish which are a critical food source for many marine mammal, seabird and fish species. Forage fish species are not included in a target species category. Management measures for the forage fish category will be specified in regulations and may include prohibitions on directed fishing, limitations on allowable bycatch retention amounts, or limitations on the sale, barter, trade or any other commercial exchange, as well as the processing of forage fish in a commercial processing facility.</p> <p>The forage fish species category would include all species of the following families:</p> <ul style="list-style-type: none"> Osmeridae (eulachon, capelin and other smelts), Myctophidae (lanternfishes), Bathylagidae (deep-sea smelts), Ammodytidae (Pacific sand lance),

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>Trichodontidae (Pacific sand fish), Pholidae (gunnels), Stichaeidae (pricklebacks, warbonnets, eelblennys, cockscombs and shannys), Gonostomatidae (bristlemouths, lightfishes, and anglemouths), and the Order Euphausiacea (krill).</p>
37	<p>Amendment 37 implemented the following measures:</p> <p>(1) A year round bottom trawl closure in the Bristol Bay Red king Crab Savings Area to directed fishing for groundfish by (cont.) vessels using non-pelagic trawl gear. The southern edge of the Savings Area between 56° and 56°10 N. lat., however, would open if a guideline harvest level for Bristol Bay red king crab is established. A portion of the annual PSC limit would be specified for the subarea;</p> <p>(2) A year round closure to all trawling in the nearshore waters of Bristol Bay, with the exception that a portion of this area- between 159° and 160°W. long. and between 58° and 58°43' N. lat. - would remain open to trawling during the period April 1 to June 15 each year;</p> <p>(3) Increased observer coverage on all vessels, including vessels using pot, jig, and longline gear fishing for groundfish in the Savings Area and on trawl vessels fishing in the seasonal open area of the Bristol Bay nearshore waters closure; and</p> <p>(4) Adjustments to the Zone 1 PSC limit for red king crab taken in trawl fisheries. The PSC limit would be specified annually based on the abundance and biomass of Bristol Bay red king crab, as shown in the adjacent table.</p>
38	<p>The provisions of BSAI Amendment 18 became the basis of Amendment 38, and the provisions of GOA Amendment 23 became the basis for Amendment 40. Thus, in the BSAI the apportionments of pollock in each subarea and season would be allocated 35% for processing by the inshore sector and 65% by the offshore sector. In the GOA, the apportionment of pollock would be allocated entirely for processing by the inshore sector, and the apportionment of Pacific cod would be allocated 90% for the inshore sector, 10% for the offshore sector. The amendments also reauthorized the CDQ pollock program with a few minor changes to the regulations. The only two substantive changes from the original plan amendments were: 1) movement of the western CVOA boundary 30 minutes to the east, and 2) allowing catcher/processors to use the CVOA if the pollock quota for processing by the inshore sector had already been harvested for the year.</p>
39	<p>The final rule limited access to the commercial groundfish fisheries in the BSAI and GOA and commercial crab fisheries in the BSAI, except for demersal shelf rockfish east of 140° W. longitude and sablefish managed under the IFQ program. The rule provided for the following: issuance of a single type of groundfish license; LLP is not applicable to waters of the State of Alaska; licenses would be issued to current owners (as of 6/17/95) of qualified vessels; licenses would be designated as catcher vessel or catcher/processor and with one of three vessel length classes; the crab and groundfish base qualifying period is 1/1/88-6/27/92 and the groundfish area endorsement qualifying period is 1/1/92-6/17/95; endorsement areas are defined as Aleutian Islands, Bering Sea, Western Gulf, Central Gulf, and Southeast Outside, or state waters shoreward of those endorsement areas; landing requirements for general license and area endorsement qualifications by vessel class; and additional provisions addressing crossover vessels, transfers, and vessel linkages. The rule also</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	included in CDQ allocations 7.5% of the TAC of groundfish and crab in the BSAI that was not originally included in the CDQ programs for pollock, halibut, and sablefish.
40	<p>Under Amendment 40 of the BSAI Groundfish FMP, PSC limits for snow crab (<i>C. opilio</i>) taken in groundfish fisheries are based on total abundance of <i>opilio</i> crab as indicated by the NMFS standard trawl survey (NPFMC 1996). The snow crab PSC cap is set at 0.1133% of the Bering Sea snow crab abundance index, with a minimum PSC of 4.5 million snow crab and a maximum of 13 (cont.) million snow crab. Snow crab taken within the “C. Opilio Bycatch Limitation Zone” (COBLZ) accrue towards the PSC limits established for individual trawl fisheries. Upon attainment of a snow crab PSC limit apportioned to a particular trawl target fishery, the COBLZ would be closed to directed fishing for species in that trawl fishery category, except for pollock with nonpelagic trawl gear. The COBLZ within the EEZ is an area defined as that portion of the Bering Sea Subarea north of 56°30' N. latitude that are west of a line connecting the following coordinates in the order listed:</p> <p style="padding-left: 40px;">56°30' N. lat., 165°00' W. long. 58°00' N. lat., 165°00' W. long. 59°30' N. lat., 170°00' W. long.</p> <p>and north along 170°00' W. longitude to its intersection with the U.S.-Russian Boundary.</p>
41	<p>The alternative adopted and approved under Amendment 41 provides for the annual specification of the revised PSC limits based on the total estimated abundance of <i>C. bairdi</i> as shown in the adjacent table. <i>C. bairdi</i> taken as bycatch within the zones accrue towards the PSC limits established for individual trawl fisheries. Upon attainment of a PSC limit apportioned to a particular trawl target fishery, that fishery is prohibited from fishing within the specified zone. Note that in 1998, the Council adopted a provision to reduce opilio crab bycatch by an additional 50,000 <i>C. bairdi</i> crab as part of the regulation prohibiting the use of bottom trawl gear for pollock fisheries.</p>
42	<p>Amendment 42 and a regulatory amendment to the IFQ Program for fixed gear Pacific halibut and sablefish fisheries in and off Alaska allowed QS initially assigned to a larger vessel category to be used on smaller vessels, while continuing to prohibit the use of QS or its associated IFQ assigned to smaller vessel categories on larger vessels. QS will continue to be assigned to vessel categories by existing criteria at Sec. 679.40(a)(5) (i) through (vi) and will retain original vessel category assignments. However, halibut and sablefish QS and their associated IFQ assigned to vessel Category B, can be used on vessels of any size and halibut QS assigned to vessel Category C likewise can be used on vessels of categories C and D. The regulations continue to prohibit the use of QS and IFQ on vessels larger than the maximum length on average (LOA) of the category to which the QS was originally assigned. It does not apply to halibut in IFQ regulatory areas 2C or to sablefish east of 140° W. long. Halibut QS assigned to vessel Category B in IFQ regulatory areas 2C and sablefish QS east of 140° W. long. are prohibited from use on vessels less than or equal to 60 ft (18.3 m) LOA except in QS blocks equivalent to less than 5,000 lb (2.3 mt) based on the 1996 Total Allowable Catch (TAC).</p>
43	<p>Amendment 43 increased the sweep-up levels for small QS blocks for Pacific halibut and sablefish from a 1,000 lb (0.45 mt) maximum for Pacific halibut and 3,000 lb (1.4 mt) maximum for sablefish to a 3,000 lb (1.4 mt) maximum and a 5,000 lb (2.3 mt) maximum, respectively. Two other changes were recommended to accompany these increases:</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>8) The base year TAC for determining the pounds would be the 1996, rather than 1994, TAC which was used for the first sweep-up levels;</p> <p>9) Once QS levels are established for the appropriate regulatory areas based on the 1996 TAC, those QS levels would be fixed (cont.) and codified. This would eliminate any confusion as to the appropriate sweep-up level in pounds, which would fluctuate with changes in the annual TAC.</p> <p>The maximum number of QS units that may be consolidated into a single QS block in each IFQ regulatory area is shown in the above table.</p>
44	<p>Amendments 44/44 provided for more conservative definitions of ABC and OFL. The fishing mortality rate used to calculate ABC was capped by the overfishing rate. The maximum allowable fishing rates were prescribed through a set of 6 tiers which are listed in descending order of preference, corresponding to descending information availability. These tiers are shown in the adjacent table. Harvest rates used to establish ABCs are reduced at low stock size levels, thereby allowing rebuilding of depleted stocks. If the biomass of any stock falls below B_{msy} or $B_{40\%}$ (the long-term average biomass that would be expected under average recruitment and $F=F_{40\%}$), the fishing mortality is reduced relative to stock status. This serves as an implicit rebuilding plan should a stock fall below a reasonable abundance level.</p>
45	<p>Ten percent of pollock and 7.5% of all other groundfish and crab TACs are set aside for the Western Alaska CDQ program.</p>
46	<p>1) <u>BSAI Pacific cod TAC Apportionments:</u> Trawl sector: 47% (The trawl apportionment will be split between catcher vessels and catcher processors 50/50.) Fixed gear sector: 51% Jig gear sector: 2%</p> <p>2) <u>Roll-overs:</u> On September 15 of each year, the Regional Director shall reallocate 100% of any projected unused amount of the Pacific cod allocated to jig vessels to the fixed gear vessels. If, during a fishing year, the Regional Director determines that vessels using trawl gear or hook-and-line or pot gear will not be able to harvest the entire amount of Pacific cod allocated to those vessels, then NMFS shall reallocate the projected unused amount of Pacific cod to vessels using the other gear type(s).</p> <p>3) <u>Halibut PSC Mortality Caps:</u> The trawl halibut PSC mortality cap for Pacific cod will be no greater than 1,600 mt. The hook-and-line gear halibut PSC mortality cap for Pacific cod will be no greater than 900 mt.</p> <p>4. <u>Review:</u> No sunset provision, but the Council will review this agreement in four years following the date of implementation.</p>
47	<p>WITHDRAWN - At the December 1997 meeting the Council was scheduled to take action approving an alternative observer program</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>structure - a Joint Partnership Agreement (JPA) between NMFS and the Pacific States Marine Fisheries Commission (PSMFC), (cont.) which would have established PSMFC as a third party procurement point for observers. This was being considered as a replacement for the repealed Research Plan (Amendment 30), in an effort to address conflict of interest and other issues in the existing pay-as-you-go program structure. Due to legal concerns of PSMFC this amendment was not approved by the Council and was never forwarded for Secretarial review. Instead, the existing pay-as-you-go program was extended for an additional time period, through year 2000. Currently, NMFS and Council staff are working on revised program structure alternatives, including a fee-based plan, and the current program will be extended through 2002.</p>
48	<p>This amendment was not formally submitted to the Secretary and no regulations have been implemented.</p>
49	<p>Amendment 49 required all vessels fishing for groundfish in the BSAI to retain all pollock and Pacific cod beginning January 1, 1998, and all rock sole and yellowfin sole beginning January 1, 2003. It established a 15-percent minimum utilization standard for all at-sea processors.</p>
50	<p>This action authorized the voluntary donation of Pacific halibut taken as bycatch in specified groundfish trawl fisheries off Alaska to economically disadvantaged individuals. Under the prohibited species donation program, NMFS expanded the existing salmon donation program to also authorize distributions by tax-exempt organizations through a NMFS-authorized distributor. The program is limited to dead halibut landed by trawl catcher vessels to shoreside processors.</p>
51	<p>As adopted by the Council in June 1998, the BSAI amendment contemplated four changes to the current inshore/offshore allocation regime. In light of the AFA, the BSAI inshore/offshore pollock allocations were disapproved, and the only change (partially) approved related to the Catcher Vessel Operational Area (CVOA). The original Amendment 51 would have changed the existing CVOA rules by excluding from the CVOA all catcher vessels that deliver pollock to the offshore component (catcher/processors and motherships). Motherships had previously been allowed to operate within the CVOA, receiving and processing pollock harvested by catcher vessels. Catcher/processor vessels had not been allowed to harvest pollock in the CVOA during the B season. In recommending the CVOA portion of Amendment 51, the Council attempted to create parity between motherships and catcher/processor vessels. NMFS approved all of the proposed amendment maintaining the CVOA with the exception of that component. This is because the AFA specifies separate allocations of the pollock TACs for the mothership and catcher/processor sectors, thereby achieving the parity intended by the Council. Hence, the exclusion of catcher vessels from the CVOA that deliver to the offshore component was an unnecessary duplication of an AFA provision, and as such, was inconsistent with National Standard 7. Note that although the approved CVOA provisions are effectively the same as they were for 1996-98, further restrictions on fishing in the CVOA were implemented in 1999 to mitigate the effects of pollock fishing on Steller sea lions and their critical habitat, within which much of the CVOA lies.</p>
52	<p>Under a vessel registration program, NMFS would establish criteria to determine which fisheries would require registration. Based on these criteria, NMFS would create a roster of "registration fisheries" that would be announced at the beginning of each year and (cont.) supplemented as necessary on an inseason basis throughout the year. Criteria for establishing a registration requirement for a fishery</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	<p>could include:</p> <ol style="list-style-type: none"> 1) the size of the TAC amount or PSC limit specified for the fishery relative to the degree of interest in that fishery, 2) a fishery for which the TAC or PSC limit was exceeded by a significant amount in the previous year and the current year’s quota and expected effort are similar, 3) a fishery for which the above two criteria may not apply but an expanded interest has developed inseason, and 4) a “mop-up” fishery. <p>Vessel operators would be required to register with NMFS a certain number of days before beginning directed fishing in a registration fishery and penalties would be established for non-compliance.</p>
53	<p>At its February 1998 meeting, the Council approved Amendment 53 to the FMP. After subtraction of reserves, this amendment would allocate 30 percent of the remaining SR/RE TAC to non-trawl gear and 70 percent of the remaining SR/RE TAC to trawl gear.</p>
54	<p>Regulations have not yet been drafted.</p>
55	<p>The alternative adopted and approved defined EFH as all habitat within a general distribution for a species life stage, for all information levels and under all stock conditions. A general distribution area is a subset of a species range. For any species listed under the Endangered Species Act, EFH includes all areas identified as "critical habitat". EFH was described in text, tables, and maps. Habitat areas of particular concern were identified as living substrates in shallow and deep waters, and freshwater habitats used by anadromous fish.</p>
56	<p>Amendment 56 revised the ABC and overfishing definitions set under Amendment 44 to be more precautionary. Like Amendment 44, the maximum allowable rates are prescribed through a set of six tiers which are listed below in descending order of preference, corresponding to descending order of information availability. For most tiers, ABC is based on $F_{40\%}$, which is the fishing mortality rate associated with an equilibrium level of spawning per recruit (SPR) equal to 40% of the equilibrium level of spawning per recruit in the absence of any fishing. To further minimize the possibility of catches jeopardizing a stock’s long term productivity, there is a buffer established between ABC and OFL. Amendment 56 modified the OFL definition from $F_{30\%}$ to $F_{35\%}$ for stocks having tiers 2-4 information.</p>
57	<p>Amendment 57 prohibited the use of non-pelagic trawl gear when participating in the BSAI pollock fisheries. The definition of a pelagic trawl is relatively complex, whereas non-pelagic trawls are all other trawls not meeting the pelagic trawl definition. Regulations that define pelagic trawl gear are listed in the accompanying table. In addition, regulations prohibit any vessel engaged in directed (cont.) pollock fishing from having 20 crabs larger than 1.5 inches carapace width onboard the vessel at any time. Crabs were chosen for the standard because they inhabit the seabed, and if caught, provide proof that a trawl has been in contact with the bottom. Vessels fishing for CDQ pollock were exempted from the non-pelagic trawl gear prohibition.</p>

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary
	Amendment 57 also reduced the bycatch limits for halibut and crab due to the bottom trawl prohibition. Halibut bycatch mortality was reduced by 100 mt, and the PSC allowance for red king crabs was reduced by 3,000 animals, for <i>C. bairdi</i> crabs by 50,000 animals, and for <i>C. opilio</i> crabs by 150,000 animals. For <i>C bairdi</i> crabs, the limit was lowered by 20,000 in Zone 1 and by 30,000 in Zone 2.
58	Amendment 58 reduced the amount of chinook salmon allowed to be taken as bycatch in BSAI trawl fisheries. Specifically, the alternative adopted did the following (1) reduced the chinook salmon PSC bycatch limit from 48,000 to 29,000 chinook salmon over a 4-year period, (2) implemented year-round accounting of chinook salmon bycatch in the pollock fishery, beginning on January 1 of each year, (3) revised the boundaries of the Chinook Salmon Savings Areas, and (4) set new closure dates. In the event the limit is triggered before April 15, the Chinook Salmon Savings Area closes immediately. The closure would be removed on April 16, but would be reinitiated September 1 and continue through the end of the year. If the limit were reached after April 15, but before September 1, then the areas would close on September 1. If the limit were reached after September 1, the areas would close immediately through the end of the year.
59	The final rule simply extended the Vessel Moratorium Program and the existing moratorium permits through December 31, 1999. The regulation also provided that no person could apply for a new moratorium permit after the original moratorium program expiration date of December 31, 1998, unless the application was based on a moratorium qualification that was used as a basis for obtaining a moratorium permit issued on or before that date.
60	Five changes were adopted and approved under these amendments: 1) a requirement that the vessel itself would be a specific characteristic of the license and could not be severed (i.e., the license could not be used on any other vessel); 2) license designations for the type of gear authorized to harvest LLP groundfish as either "trawl" or "non-trawl" gear (or both); 3) rescission of the Community Development Quota (CDQ) exemption and thus the requirement that CDQ vessels hold a crab or groundfish license; 4) the addition of a crab recency requirement which requires one landing during 1/1/96-2/7/98 in addition to the general license and area endorsement qualifications; and 5) allowance of limited processing (1 mt) for vessels <60' LOA with catcher vessel designations. The most significant addition under these amendments was the recent participation requirement of at least one landing in the king and Tanner crab fisheries between January 1, 1996 and February 7, 1998, which applied only to the base qualifying period under the crab LLP.
61	Regulations establish the sector allocations of pollock, define the eligible vessels and processors, define the vessel/processor co-op linkages (which vessels are eligible for which co-ops), make allocations of the pollock TAC among each of the co-ops, and define the sideboard amounts of crab and non-pollock groundfish (based on historical share) that can be harvested and processed by the (cont.) AFA operators, in both the BSAI and the GOA.
64	Specific provisions for the accounting of these directed fishing allowances and the transfer of unharvested amounts of these allowances to other vessels using hook-and-line or pot gear would be set forth in the implementing regulations. As proposed, Amendment 64 would expire December 31, 2003, based on the reasoning that three years is sufficient time to address the issue of increasing competition in the BSAI cod fishery before reconsidering the issue in light of other proposed impending changes, including proposed BSAI Pacific cod

Table 2.1. Amendments to the Fishery Management Plan for the Bering Sea/Aleutian Islands Groundfish.

Amendment	Summary															
	fixed gear and species endorsements on permits issued under the license limitation program (see BSAI Amendment 67).															
65	<p>At the February 2000 meeting, the Council reviewed an initial draft of a proposed amendment that would consider identifying additional HAPC, and two management measures to protect HAPC from fishing effects. The first measure considered would potentially prohibit directed fishing for certain HAPC biota (corals, sponges, kelp [including rockweed] and mussels). The second measure would establish several marine protected areas where Gorgonian corals are found in abundance. Gorgonian corals have been shown to be important shelter for rockfish and other fish species, are very long lived, easily damaged by fishing gear, and slow to recover from damage. Based on public testimony, and input from its advisory committees, the Council voted to split the amendment and associated analysis into two parts. Part one, which the Council took final action on in April, would allow for control on the harvest of HAPC biota, based on the following problem statement.</p> <p style="padding-left: 40px;">The Council recognizes that some invertebrates (corals, sponges, mussels, rockweed and kelp), which provide important habitat for fish have the potential to be developed into large-scale commercial fisheries. The Council currently has little or no controls on the harvesting of these invertebrates. Adopting management measures as a precautionary approach would allow the Council to control any commercial fishery that might develop.</p>															
67	<p>The preferred alternative identified by the Council consists of different qualification criteria for freezer longliners, longline catcher vessels, pot catcher processors, and pot catcher vessels, as outlined below. Additional provisions addressing the combining of catch histories, hardships, multiple endorsements, and bait landings will be detailed in the proposed rule upon Secretarial approval.</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Vessel Type</u></th> <th style="text-align: left;"><u>Participation Years</u></th> <th style="text-align: left;"><u>Harvest Requirement</u></th> </tr> </thead> <tbody> <tr> <td>Freezer longline vessels</td> <td>Any one year 1996-1999</td> <td>270 mt in any one year</td> </tr> <tr> <td>Longline catcher vessels</td> <td>No action for vessels <60 feet LOA Vessels >60 feet: any one year 1995-1999</td> <td>7.5 mt in any one year*</td> </tr> <tr> <td>Pot catcher processors</td> <td>Any two years 1995-1998</td> <td>300,000 lbs in each two years</td> </tr> <tr> <td>Pot catcher vessels</td> <td>No action for vessels <60 feet LOA Vessels >60 feet: any two years 1995-1999</td> <td>>100,000 lbs in each two years (cont.)</td> </tr> </tbody> </table> <p>*Jig landings of cod (by vessels of any length) count towards qualification for the endorsement as if they had been made with longline gear.</p>	<u>Vessel Type</u>	<u>Participation Years</u>	<u>Harvest Requirement</u>	Freezer longline vessels	Any one year 1996-1999	270 mt in any one year	Longline catcher vessels	No action for vessels <60 feet LOA Vessels >60 feet: any one year 1995-1999	7.5 mt in any one year*	Pot catcher processors	Any two years 1995-1998	300,000 lbs in each two years	Pot catcher vessels	No action for vessels <60 feet LOA Vessels >60 feet: any two years 1995-1999	>100,000 lbs in each two years (cont.)
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Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

Amendment	Summary
1	The regulation revised the original FMP only slightly, extending the measures through October 31, 1979, to coincide with a fishing season start of November 1.
2	The regulation increased the amount of pollock held in reserve to 133,800 mt, with appropriate increases in the reserves of species taken incidental to fishing for pollock, and established the special joint reserve and stipulated the method for calculating the foreign allowance, wherein: $TALFF = (0.8 OY) - \text{domestic annual harvest} - \text{special joint venture reserve}$. The regulation also provided for 25% of the initial reserve to be allocated to the TALFF every two months, unless it was determined that the U.S. fleet could harvest all of the remaining reserve in the fishing year. That determination would be based on: 1) reported U.S. catch and effort by species and area; 2) projected U.S. catch and effort by species and area; and 3) projected and utilized processing capacity of U.S. fish processors. The regulation also stipulated that if part of the scheduled 25% apportionment to the TALFFs was withheld and the U.S. fleet failed to achieve the anticipated harvest levels in the next period, the amount of fish previously withheld would be made available to the TALFFs on the next bimonthly date.
3	The implementing regulations allowed for the foreign longline fleet to take the entire Chirikof TALFF for Pacific cod (1,500 mt), and any apportioned reserves in that fishing area, in the Chirikof fishing area west of 157° W. longitude.
4	<p>The regulations implemented the following provisions:</p> <ol style="list-style-type: none"> 1) Reduce the number of fishing areas in the GOA from five to three (Western, Central, Eastern), to reduce the regulatory burden on the fisheries while still preventing localized depletion. 2) Allow foreign fishing within the 3-12 mile zone between 169° and 170° W longitude to correct an omission in the FMP. 3) Remove the restriction which allowed only 25% of the total allowable level of foreign fishing (TALFF) to be taken from December 1 to May 31. The restriction was proved unnecessary since foreign trawl operations use pelagic trawls in the winter. 4) Allow foreign longlining for sablefish seaward of 400 meters (instead of 500 meters) from May 1 to September 30 in the area between 140° and 170° W longitude. Because incidental halibut catch by longliners is low during the summer, this change increased areas for foreign nations to catch sablefish while adequately protecting halibut stocks. 5) Permit a directed longline fishery for Pacific cod between 140° and 157° W longitude seaward of 12 miles, except during the U.S. halibut season. By encouraging longlining instead of trawling for Pacific cod, the incidental mortality of halibut would be reduced. 6) Exempt foreign vessels from the requirement that fishing by all vessels of a nation in a fishing area cease when the allocation for any species has been taken. The exemption does not apply if the allocation reached is for a target species of the longliners. This was to prevent the foreign longline fishery from being closed by the foreign trawl fishery. 7) Increase the squid optimum yield to 5,000 mt (from 2,000 mt) to allow a sufficient incidental catch for foreign nations. 8) Increase the Atka mackerel optimum yield to 26,800 mt (from 24,800 mt), based on new data indicating higher historical catches. 9) Remove the domestic one-hour tow restriction. This was deemed unnecessary protection for halibut given the separate incidental catch quota on halibut for domestic fisheries. (cont.) 10) Remove the domestic requirement for the use of off-bottom trawls from December 1- May 1. This measure was also considered unnecessary for halibut protection.

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	11) Require domestic permits to be renewed annually and domestic reporting (fish tickets) to be submitted within 7 days (instead of 3 days). This would make the Federal and State regulations consistent.
5	Amendment 5 created a new species category specifically for grenadiers with a separate domestic annual harvest, total allowable level of foreign fishing, and MSY/OY of 13,200 mt. The MSY/OY was based on the recorded average grenadier catch for the previous twelve years. Since the grenadier population was not considered in the development of the OY for the “Other Species” category, that category’s OY remained the same. The deletion of grenadiers from the “Other Species” category was published in a separate rule on June 29, 1979 (44 FR 37937).
6	The regulations lowered the estimates of domestic annual harvest and reallocated the surplus to the TALFF, increasing the 1978 TALFF by 27,700 mt for all species of groundfish combined. Specifications by species are provided in the table below.
7	The regulations implemented the following six provisions: <ol style="list-style-type: none"> 1) Extend the FMP through October 31, 1980; 2) Implement the provisions of the Processor Preference Amendment (PL 95-354), which would establish a mechanism to periodically review and reassess the domestic annual harvest and the reserve to TALFF; 3) Increase the Pacific cod OY from 34,800 mt to 60,000 mt and increase the Atka mackerel OY from 26,800 mt to 28,700 mt; 4) Create a new category and a Gulf-wide OY of 3,750 mt for thornyhead rockfish; 5) Establish that the Council will consider, on a case-by-case basis, the possibility of time and area closures to joint venture operations to allow a domestic processor to process the catch; (note: this provision was disapproved by the Secretary) 6) Create new domestic reporting requirements to facilitate better estimates of domestic annual harvesting and processing capabilities.
8	The amendment included six measures: <ol style="list-style-type: none"> 1. Change plan management year to January 1-December 31 and remove plan expiration date; 2. Set Gulfwide OY for squid, thornyhead rockfish, other rockfish, and other species; 3. Establish four species categories: target species, other species, unallocated species, and nonspecified species; 4. Establish three regulatory districts for sablefish management- Yakutat, Southeast Outside, and Southeast Inside; 5. Adjust reserve release schedule to 40% in April, 40% in June, 20% in August; allow transfer of domestic allocations to foreign Total Allowable Level of Foreign Fishing (TALFF); and 6. Require biodegradable panels on sablefish pots. <p>A seventh measure which would have authorized the Regional Director to issue field orders to resolve gear conflicts between foreign and domestic fishermen, was disapproved by NMFS for lack of specificity on January 11, 1982.</p>
9	The amendment replaced six small fixed gear areas around Kodiak with a larger, single closed area to prevent gear conflicts between foreign trawlers and U.S. crab fishermen and to prevent preemption of crab grounds during the crab season by foreign trawlers. It remained closed from 2 days ahead of the Kodiak king crab season, normally September 15 th through February 15 th .

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	The Kodiak Gear Area (a.k.a. Lechener Line) is bounded as indicated at right.
10	The amendment reduced the acceptable biological catch for POP from 29,000 mt in the Eastern Regulatory Area, to 875 mt, the OY from 14,400 mt to 875 mt, and allowed domestic and foreign fisheries 500 mt and 200 mt, respectively, for bycatch purposes. Federal waters east of 140° W were closed to all foreign fishing, and only pelagic trawling with recording net-sonde devices was allowed in waters between 140° and 147° W all year. All domestic fishing sanctuaries east of 140°W were consequently deleted as they were no longer necessary.
11	The amendment made the following changes: <ol style="list-style-type: none"> 1. Increased OY for pollock in the Central Area of the Gulf from 95,200 mt to 143,000 mt; 2. Divided the Yakutat district into east Yakutat (137°-140° W) and West Yakutat (140°-147° W) for sablefish management; 3. Reduced OY for sablefish from 12,300 mt to a range of 7,730-8,900 mt and apportioned it among the regulatory areas and districts; 4. Established a framework procedure for Regional Administrator to annually determine domestic (DAP) and joint venture (JVP) components of domestic annual harvest (DAH) for each species OY; 5. Eliminated the domestic non-processed (bait and personal consumption) component of DAH, combining it within the purely domestic component, DAP; 6. Increased flexibility of Regional Administrator to reapportion reserves and surplus DAH to foreign fishing (TALFF); 7. Authorized Regional Administrator to impose time-area closures on foreign nations to conserve resources; and 8. Imposed radio/telephone catch reporting requirements on domestic vessels leaving State waters to land fish outside Alaska.
12	Amendment 12 prohibited the use of pot longline gear for sablefish between 140°W longitude and Cape Addington.
13	The final regulations contained the following two actions: <ol style="list-style-type: none"> 1) Adjusted the management of the pollock resource by combining the Western and Central Regulatory Areas of the Gulf of Alaska for managing the pollock fisheries only; and 2) Increased the optimum yield for the combined area from 200,000 mt to 400,000 mt.
14	The amendment made the following changes: <ol style="list-style-type: none"> 1. Established gear/area restrictions and OY apportionments to gear types for sablefish; 2. Established a Central Southeast Outside District with 600 mt OY for demersal shelf rockfish; (cont.) 3. Changed OYs for pollock, Pacific ocean perch, other rockfish, Atka mackerel, and other species; 4. Established catcher/processor reporting requirements; 5. Implemented framework procedure for setting and revising halibut PSC limits; 6. Implemented NMFS habitat policy; and 7. Set seasons for hook and longline and pot sablefish fisheries.

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

<p>15</p>	<p>Regulations designated:</p> <ol style="list-style-type: none"> (1) a multispecies OY as a Gulf-wide range of 116,000-800,000 mt, set a framework procedure to set target quotas for each species category, and set administrative procedures for setting PSC limits in the Gulf fishery; (2) revised recordkeeping and reporting requirements such that at-sea catcher/processor and mothership vessels must submit weekly catch reports regardless of how long their catch was retained before landing; (3) Type I, Type II and Type III areas for special bottom trawl restrictions to protect king crab. Type I areas have very high king crab concentrations and, to promote rebuilding of the crab stocks, are closed all year to all trawling except with pelagic gear. Type II areas have lower crab concentrations and are only closed to non-pelagic gear from February 15 through June 15. Type III areas are adjacent to Type I and II areas and have been identified as important juvenile king crab rearing or migratory areas. Type III areas become operational following a determination that a "recruitment event" has occurred. The Regional Administrator will classify the expanded Type III area as either Type I or II, depending on the information available. A "recruitment event" is defined as the appearance of female king crab in substantially increased numbers (when the total number of females estimated for a given district equals the number of females established as a threshold criterion for opening that district to commercial crab fishing). A recruitment event closure will continue until a commercial crab fishery opens for that district or the number of crabs drops below the threshold level for that district. <p>The Alitak Flats/Towers and Marmot Flats areas are Type I areas, closed to non-pelagic trawls all year. Chirikof Island and Barnabas are Type II areas, closed to non-pelagic trawls from February 15 to June 15. These areas encompass 80% to 90% of the known female king crab stocks. When necessary, Type III areas will be closed by regulatory amendment; the Regional Administrator will specify which of the Type III areas are closed and whether the closure is for an entire year or only a portion of a year;</p> <ol style="list-style-type: none"> (4) authority by the RD to open and close fisheries using the best available data (Check with FR).
<p>16</p>	<p>The regulations implemented the following provisions to the both the GOA and BSAI FMPs:</p> <ol style="list-style-type: none"> 1) Augmented the current catcher/processor and mothership reporting requirements with at-sea transfer information, specifically, a Cargo Transfer/Off-Loading Log and Product Transfer Report; (cont.) 2) Revised the definition of prohibited species to include Pacific salmonids, Pacific herring, Pacific halibut, king crab, Tanner crab, and steelhead trout. Respecified the other three categories: <ol style="list-style-type: none"> a) Target species—pollock, Pacific cod, flounders, rockfish, and sablefish b) Other species—Atka mackerel, squid, sculpins, sharks, skates, eulachon, smelts, capelin, and octopus c) Non-specified species—those species taken incidentally in the groundfish fisheries but are not managed by the FMP. No catch records are required; 3) Required the public comment period for proposed annual specifications and prohibited species catch limits to be 30 days following the date of filing of the notice for public inspection with the Office of the Federal Register.

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	In addition, several minor regulatory changes were included that apply only to the GOA FMP: 1) the term “target quotas” for groundfish was changed to “total allowable catches”; 2) general reorganization and editing; 3) the addition of a vessel safety section; and 4) removal of the reserve category for some species of groundfish.
17	Amendment 17 required that all vessels of the U.S. receiving EEZ-caught fish would have to hold a Federal permit and thus would have to comply with the weekly reporting requirements.
18	<p>Amendment 18 to the groundfish FMPs authorized a comprehensive domestic fishery observer program. The 1990 and 1991 Observer Plans required specific levels of observer coverage which varied with size of fishing vessel and quantity of fish processed by floating and shoreside processors. These requirements were established because it was recognized that living marine resources could not be effectively managed without the types of information that were either available only or most efficiently through an observer program.</p> <p>The Observer Plans required that owners and operators of vessels and shoreside processing facilities participating in the groundfish fishery arrange for and pay for the cost of placing observers aboard their vessels and at their shoreside processing facilities beginning in January, 1990. Each vessel or processor required to have observer coverage is responsible for the cost of obtaining the required observers from a certified contractor. The cost averaged between \$5,800 and \$7,100 per observer month in 1991.</p> <p>Amendment 18 also:</p> <ol style="list-style-type: none"> (1) established Shelikof Strait area as a management district; (2) closed areas around Kodiak Island to bottom trawl gear; (3) established for one year, interim Pacific halibut PSC limits for fixed gear (750 mt) and trawl gear (2,000 mt); (4) deleted fishing season dates from the FMPs but retained them in regulation; and (5) clarified authority to recommend TACs for additional or fewer target species within the “target species” category.
19	The amendment implemented rules that regulated the practice of stripping roe (eggs) from female pollock and discarding female (cont.) and male pollock carcasses without further processing, and seasonally allocated the TAC of pollock. Season opening dates established were as follows for the GOA: January 1, April, July, and October, and for the BSAI: January 1 and June 1. To get at the issue of roe stripping, product recovery rate standards were established, which if exceeded would constitute a violation. The recovery rate standard established was 10 percent of the total round-weight equivalent of pollock and other pollock products onboard a vessel at any time during a fishing trip. To extrapolate round weight equivalents, the rule established product recovery rates as follows: fillet (18%), surimi (15%), mince (17%), meal (17%), and head&gut (50%).
20	The IFQ Program was approved for the Pacific halibut (via regulatory amendment) and sablefish fixed gear fisheries in the Federal waters of the BSAI and GOA, and these fisheries have been managed under the program since 1995. The regulations outline several key provisions of the program: initial allocation of quota shares (QS); vessel categories; transfer provisions; use and ownership provisions; the annual process for allocating quota shares; and the establishment of Community Development Quotas. The regulations state that legal landings of halibut or sablefish harvested with fixed gear had to occur at any time during 1988-1990 to qualify for an initial allocation of quota share. Generally, if a vessel owner or lessee is qualified, their initial quota share would be based on their highest total landing of

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	<p>halibut for any 5 years of the 7-year base period 1984-1990. For sablefish, the initial quota share would be based on the highest total landing of sablefish for any 5 years of the 6-year base period 1985-1990. Each person eligible to receive quota share would have it assigned to one of four vessel categories: “A”-freezer vessels of any length; “B”- catcher vessels greater than 60'; “C”- catcher vessels less than or equal to 60' for sablefish, or between 35'-60' for halibut; “D”- catcher vessels less than or equal to 35' for halibut. Initial quota share would be assigned to the vessel category that a person’s most recent fixed gear landings of groundfish or halibut were caught by that vessel.</p>
21	<p>The amendment contained 8 approved management measures; those pertaining to the GOA follow:</p> <ul style="list-style-type: none"> (6) Apportioned PSC limits into bycatch allowances for trawl fishery categories; (7) Allowed separate apportionment of halibut PSC to hook and line and pot gear in the GOA; (8) Allowed seasonal allocation of halibut and crab PSC; (9) Established procedures for interim TAC specifications; (10) Established fishing gear restrictions (definition of pelagic trawl, biodegradable panels & halibut excluders on pot gear); (11) Modified authorization language that allows demersal shelf rockfish in SE Alaska to be managed by the State; (12) Established definitions of overfishing. (13) Modified PSC limits and bycatch limitation zones for halibut, bairdi crab, and red king crab in the BSAI <p>Later revisions to the amendment included addition of a vessel incentive program, which would issue civil penalties (fines) to vessels that exceeded seasonal fixed bycatch rate standards for halibut and crab taken in specified target fisheries.</p>
22	<p>This amendment allows the NMFS Regional Director, after consulting with the Director of the Alaska Fishery Science Center and with the Council to authorize for limited experimental purposes, the target or incidental harvest of groundfish that would otherwise be (cont.) prohibited. The amendment also combined statistical area 68 with statistical area 65.</p>
23	<p>The alternative adopted and approved defined the inshore and offshore components of the fisheries. BSAI Amendment 18 was only partially approved, allocating 35% of the 1992 non-roe pollock season TAC to the inshore component, and the remaining 65% to the offshore component. The portion that was not approved would have further allocated pollock through 1995: the inshore allocation would have increased to 40% in 1993 and 45% in both 1994 and 1995. A NMFS economic review indicating a large net loss to the Nation as a result of this action provided the rationale for disapproval by the Secretary of Commerce. The GOA inshore component was allocated 90% of the Pacific cod TAC and 100% of the pollock TAC for each fishing year. While catcher/processors from the offshore component would not be able to conduct directed pollock fishing in the GOA, they would be allowed appropriate bycatch amounts.</p>
24	<p>Amendments 19/24 established three FMP amendment management measures. One pertained to the GOA FMP and its implementing regulations:</p> <ul style="list-style-type: none"> (1) Delay the season opening date of the GOA groundfish trawl fisheries to January 20 of each fishing year to reduce salmon and halibut bycatch rates; (2) Further delay the season opening date of the GOA trawl rockfish fishery to the Monday closest to July 1 to reduce halibut and

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	<p>chinook salmon bycatch rates;</p> <p>(3) Change directed fishing standards to further limit halibut bycatch associated with bottom trawl fisheries;</p> <p>(4) Expand the vessel incentive program to address halibut bycatch rates in all trawl fisheries.</p>
25	<p>Regulations authorized by this amendment implemented the following measures:</p> <p>(1) Areas are closed year-round to fishing by vessels using trawl gear within 10 nautical miles of key Steller sea lion rookeries located in the GOA and BSAI management areas;</p> <p>(2) Areas are closed within 20 nm of five sea lion rookeries to directed pollock fisheries during the “A” season. These rookeries are Sea Lion Rocks, Akun Island, Akutan Island, Seguam Island, and Agligadak Island;</p> <p>(3) In the GOA, the specified total allowable catch for pollock in the combined western/central area is further divided among three pollock management districts: Area 61 (170°-159° W. longitudes), Area 62 (159°-154° W. longitudes), and Area 63 (154°-147° W. longitudes). The Shelikof Strait district was eliminated. To prevent excessive accumulation of unharvested portions in any quarterly allowance of the pollock TAC, a limit of 150 percent of the initial quarterly allowance in each pollock management district was established.</p>
26	<p>The regulation simply made the provisions of Amendment 18 permanent. The Council designated Type I, Type II and Type III areas for special bottom trawl restrictions to protect king crab. Type I areas have very high king crab concentrations and, to promote rebuilding of the crab stocks, are closed all year to all trawling except with pelagic gear. Type II areas have lower crab concentrations and are only closed to non-pelagic gear from February 15 through June 15. Type III areas are adjacent to Type I and II areas and have been identified as important juvenile king crab rearing or migratory areas. Type III areas become operational following a (cont.) determination that a "recruitment event" has occurred. The Regional Administrator will classify the expanded Type III area as either Type I or II, depending on the information available. A "recruitment event" is defined as the appearance of female king crab in substantially increased numbers (when the total number of females estimated for a given district equals the number of females established as a threshold criterion for opening that district to commercial crab fishing). A recruitment event closure will continue until a commercial crab fishery opens for that district or the number of crabs drops below the threshold level for that district.</p> <p>The Alitak Flats/Towers and Marmot Flats areas are Type I areas, closed to non-pelagic trawls all year. Chirikof Island and Barnabas are Type II areas, closed to non-pelagic trawls from February 15 to June 15. These areas encompass 80% to 90% of the known female king crab stocks.</p> <p>When Type III areas are closed by regulatory amendment, the Regional Administrator will specify which of the Type III areas are closed and whether the closure is for an entire year or only a portion of a year.</p>
27	<p>This amendment allows the Secretary to promulgate regulations establishing areas where specific types of fishing gear may be tested, to be available for use when the fishing grounds are closed to that gear type. Specific gear test areas contained in regulations that implement the FMP, and changes to the regulations, will be done by regulatory amendment. These gear test areas would be established in order to provide fishermen the opportunity to ensure that their gear is in proper working order prior to a directed fishery opening. The test areas</p>

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	<p>must conform to the following conditions:</p> <ul style="list-style-type: none"> (1) Depth and bottom type must be suitable for testing the particular gear type; (2) Must be outside State waters; (3) Must be in areas not normally closed to fishing with that gear type; (4) Must be in areas that are not usually fished heavily by that gear type; and (5) Must not be within a designated Steller sea lion protection area at any time of the year. <p>The rule implementing this amendment established three trawl test areas: Dutch Harbor (54° 40' to 55° 00'N; 166° 00' to 167° 00'W), Sand Point (54° 35' to 54° 50'N; 160° 30' to 161° 00'W), and Kodiak (57° 23' to 57° 37'N; 151° 25' to 152° 02'W). The regulation further required that the trawl codend must be left unzipped so as not to retain fish, that groundfish may not be onboard, and that the time used to test gear would not contribute to observer coverage requirements.</p>
28	<p>After several proposed moratoriums and revisions, the final rule required a moratorium permit for vessels within specific vessel categories that harvest groundfish and BSAI Area crab resources off Alaska. Generally, a vessel qualified for a moratorium permit if it made a legal landing of any moratorium species during the qualifying period of January 1, 1988 through February 9, 1992. In addition, a vessel that made a legal landing during the qualifying period, in either a groundfish or crab fishery, but not both, could cross over as a new vessel in the fishery in which it did not make a legal landing in the qualifying period provided: 1) it uses the same gear type in the new fishery as it used to qualify for the moratorium in the other fishery; or 2) it made a legal landing in the crossover fishery (cont.) during the qualifying period and it uses only the same gear type it used in that period.</p>
29	<p>The Salmon Donation Program authorizes the distribution of Pacific Salmon taken as bycatch in the groundfish trawl fisheries in the groundfish fisheries off Alaska to economically disadvantaged individuals through NMFS authorized distributor selected by the Regional Director in accordance with federal regulations implemented under the FMP.</p>
30	<p>The Magnuson-Stevens Act authorized the Council and the Secretary to establish a North Pacific Fisheries Research Plan which: (1) requires that observers be stationed on fishing vessels and at fish processing facilities, and (2) establishes a system of fees to pay for the cost of implementing the Research Plan. The Research Plan, as adopted under this amendment, contained four objectives and elements that included observer employment and contracts, observer duties, data collection and transmission, annual determination on coverage level, inseason changes to coverage levels, establishment of an observer oversight committee, coordination between the NMFS groundfish and ADF&G shellfish observer programs, a fee assessment (up to 2% of ex-vessel value of harvested fish), and details on fee collection and contingency plans in case of funding shortfalls.</p>
31	<p>Amendment 31 created a separate target category for Atka mackerel in the GOA groundfish FMP. This meant that harvest levels of Atka mackerel would be based on biological stock assessments. Although the catch would primarily occur in the Western Gulf, TAC's for Atka mackerel would be set Gulfwide to avoid waste and discarding of the small amount caught in the other subareas. The species composition of the other species category would remain the same, with the exception of Atka mackerel. TACs for other species in the GOA would increase to include 5% of the TAC for Atka mackerel.</p>

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

32	<p>The alternative chosen was projected in modeling simulations to rebuild POP biomass to a target level (B_{MSY}) in about 14 years by harvesting POP at a fishing mortality rate lower than the optimum rate. The target biomass B_{MSY} is the total biomass of mature females that would produce the maximum sustainable yield, on average; this number is currently estimated at 150,000 mt. The optimal fishing mortality rate is the rate that maximizes expected biological and economic yields over a range of plausible stock-recruitment relationships.</p> <p>Amendment 32 establishes the procedure for deriving the annual GOA TACs for POP. POP stocks are considered to be rebuilt when the total biomass of mature females is equal to, or greater than, B_{MSY}. Annual TACs will be established as follows:</p> <ol style="list-style-type: none"> 4) determine the current biomass, B_{MSY}, and the optimal fishing mortality rate; 5) determine the fishing mortality rate halfway between the optimal fishing mortality rate and the fishing mortality rate estimated to be sufficient to supply unavoidable bycatch of POP based on 1992 bycatch rates; 6) when the current biomass of mature females is less than B_{MSY}, adjust the resultant fishing mortality rate in (b) by the ratio of current biomass to B_{MSY}. When B_{MSY} is attained, the fishing mortality rate will be the optimal fishing mortality rate; 7) the GOA TAC of POP is the amount of fish resulting from the adjusted fishing mortality rate in (c); and 8) the TAC is apportioned among regulatory areas in proportion to POP biomass distribution.
33	None listed
34	<p>The alternative adopted and approved raised the sablefish Community Development Quota allocation limit for qualified applicants from 12% to 33% in order to allow total allocation of the sablefish CDQ reserve; removed the inadvertent inclusion of the CDQ program in the FMP for the GOA; and expanded the types of evidence that may be used to verify vessel leases for the halibut and sablefish individual fishing quota program. It was emphasized that this action did not change the amount of sablefish available for harvest by persons participating in the Pacific halibut and sablefish IFQ program.</p>
35	<p>The alternative adopted and approved provided that initial allocations of quota share that represent less than 20,000 lb of IFQ in the implementation year will be issued as a block, 2) quota share that represents 20,000 lb or more of IFQ in the implementation year will be “unblocked” quota share, and 3) quota share in a block cannot be separated and will have to be transferred as a block. Fishermen could own two blocks of halibut and two blocks of sablefish quota share in each area, but persons holding any amount of unblocked quota share are limited to one block of quota share per area. A sweep up provision allowed fishermen to combine small amounts into fishable amounts: halibut blocks can be combined to a sum of less than 1,000 lbs and sablefish blocks can be combined until the sum reaches 3,000 lbs. The amendment also clarified that blocked and unblocked quota share would be transferable subject to the approval of the NMFS Regional Director and the regulations. The Modified Block Proposal created the potential that some quota share would become non-transferable because the size would exceed the quota share use limits established in 50 CFR 676.22 (e) and (f); the alternative adopted solved the issue of nontransferability by allowing the transfer of a quota share block exceeding the use limits by dividing the block into two blocks.</p>
36	<p>The amendment exempted some CDQ compensation QS from the block provision and allowed for a one year period of relief (one-time transfer) from the restriction against transferring CDQ compensation QS across vessel length categories. Regulations state that if a</p>

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	<p>person is issued CDQ compensation QS for an area where the person already has regular QS, then their CDQ compensation QS is combined with their existing QS and is either “blocked” or “unblocked” depending on the sum total of their QS (this makes much of the CDQ compensation QS unidentifiable after issuance). If a person is issued CDQ compensation QS for an area in which the person doesn’t have other QS, the QS is left unblocked. The exemption does not include Category “A” vessels—vessels of any length authorized to process IFQ species.</p>
37	<p>The alternative adopted and approved authorized the processing of fish other than IFQ halibut or IFQ sablefish on board the harvesting vessel by persons authorized to harvest IFQ sablefish based on an annual allocation of IFQ assigned to vessel categories B or C. This authorization is not extended to persons authorized to harvest IFQ halibut, due to the fact that halibut is characteristically prosecuted by local vessels that do not have onboard processing capabilities. Several modifications were also made to the regulations implementing the IFQ program in order to accommodate the new provision. In addition, while non-IFQ species could be frozen onboard, the freezing of IFQ sablefish caught with catcher vessel quota share on a freezer vessel would continue to be prohibited.</p>
38	<p>The alternative adopted and approved allowed the Council to recommend a POP total allowable catch at or below the amount (cont.) dictated by the formula in the Rebuilding Plan. The regulations specify that any downward adjustments would be based on biological or resource conservation concerns about the POP stock or associated with the POP fishery that are not accounted for in the Rebuilding Plan or the annual stock assessment reports. The amendment only gives the Council the alternative of recommending a lower POP TAC based on resource conservation concerns, and not socioeconomic concerns. Under Amendment 38, the formula in the Rebuilding Plan would be considered the upper bound limit for the POP TAC.</p>
39	<p>This amendment defined a forage fish species category and authorized that the management of this species category be specified in regulations in a manner that prevents the development of a commercial directed fishery for forage fish which are a critical food source for many marine mammal, seabird and fish species. Forage fish species are not included in a target species category. Management measures for the forage fish category will be specified in regulations and may include prohibitions on directed fishing, limitations on allowable bycatch retention amounts, or limitations on the sale, barter, trade or any other commercial exchange, as well as the processing of forage fish in a commercial processing facility.</p> <p>The forage fish species category would include all species of the following families: Osmeridae (eulachon, capelin and other smelts), Myctophidae (lanternfishes), Bathylagidae (deep-sea smelts), Ammodytidae (Pacific sand lance), Trichodontidae (Pacific sand fish), Pholidae (gunnells), Stichaeidae (pricklebacks, warbonnets, eelblennys, cockscombs and shannys), Gonostomatidae (bristlemouths, lightfishes, and anglemouths), and the Order Euphausiacea (krill).</p>

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

40	<p>The provisions of BSAI Amendment 18 became the basis of Amendment 38, and the provisions of GOA Amendment 23 became the basis for Amendment 40. Thus, in the BSAI the apportionments of pollock in each subarea and season would be allocated 35% for processing by the inshore sector and 65% by the offshore sector. In the GOA, the apportionment of pollock would be allocated entirely for processing by the inshore sector, and the apportionment of Pacific cod would be allocated 90% for the inshore sector, 10% for the offshore sector.</p>
41	<p>The final rule limited access to the commercial groundfish fisheries in the BSAI and GOA and commercial crab fisheries in the BSAI, except for demersal shelf rockfish east of 140° W. longitude and sablefish managed under the IFQ program. The rule provided for the following: issuance of a single type of groundfish license; LLP is not applicable to waters of the State of Alaska; licenses would be issued to current owners (as of 6/17/95) of qualified vessels; licenses would be designated as catcher vessel or catcher/processor and with one of three vessel length classes; the crab and groundfish base qualifying period is 1/1/88-6/27/92 and the groundfish area (cont.) endorsement qualifying period is 1/1/92-6/17/95; endorsement areas are defined as Aleutian Islands, Bering Sea, Western Gulf Central Gulf, and Southeast Outside, or state waters shoreward of those endorsement areas; landing requirements for general license and area endorsement qualifications by vessel class; and additional provisions addressing crossover vessels, transfers, and vessel linkages. The rule also included in CDQ allocations 7.5% of the TAC of groundfish and crab in the BSAI that was not originally included in the CDQ programs for pollock, halibut, and sablefish.</p>
42	<p>Amendment 42 and a regulatory amendment to the IFQ Program for fixed gear Pacific halibut and sablefish fisheries in and off Alaska allowed QS initially assigned to a larger vessel category to be used on smaller vessels, while continuing to prohibit the use of QS or its associated IFQ assigned to smaller vessel categories on larger vessels. QS will continue to be assigned to vessel categories by existing criteria and will retain original vessel category assignments. However, halibut and sablefish QS and their associated IFQ assigned to vessel Category B can be used on vessels of any size and halibut QS assigned to vessel Category C likewise can be used on vessels of categories C and D. The regulations continue to prohibit the use of QS and IFQ on vessels larger than the maximum length on average (LOA) of the category to which the QS was originally assigned. It does not apply to halibut in IFQ regulatory areas 2C or to sablefish east of 140 °. W. long. Halibut QS assigned to vessel Category B in IFQ regulatory areas 2C and sablefish QS east of 140°W. long. are prohibited from use on vessels less than or equal to 60 ft (18.3 m) LOA except in QS blocks equivalent to less than 5,000 lb (2.3 mt) based on the 1996 Total Allowable Catch (TAC).</p>
43	<p>Amendment 43 would increase the sweep-up levels for small QS blocks for Pacific halibut and sablefish from the current 1,000 lb (0.45 mt) maximum for Pacific halibut and 3,000 lb (1.4 mt) maximum for sablefish to a 3,000 lb (1.4 mt) maximum and a 5,000 lb (2.3 mt) maximum, respectively. Two other changes were recommended to accompany these increases:</p> <ul style="list-style-type: none"> 9) The base year TAC for determining the pounds would be the 1996, rather than 1994, TAC which was used for the first sweep-up levels; 10) Once QS levels are established for the appropriate regulatory areas based on the 1996 TAC, those QS levels would be fixed and codified. This would eliminate any confusion as to the appropriate sweep-up level in pounds, which would fluctuate with changes in the annual TAC.

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

44	Amendment 44 provided for more conservative definitions of ABC and OFL. The fishing mortality rate used to calculate ABC was capped by the overfishing rate. The maximum allowable fishing rates were prescribed through a set of 6 tiers which are listed in descending order of preference, corresponding to descending information availability. These tiers are shown in the adjacent table. Harvest rates used to establish ABCs are reduced at low stock size levels, thereby allowing rebuilding of depleted stocks. If the biomass of any stock falls below B_{msy} or $B_{40\%}$ (the long-term average biomass that would be expected under average recruitment and $F=F_{40\%}$), the fishing mortality is reduced relative to stock status. This serves as an implicit rebuilding plan should a stock fall below a reasonable abundance level.
45	Amendment 45 authorized seasonal allowances of pollock total allowable catch (TAC) to be specified for the combined (cont.) Western/Central (W/C) Regulatory Areas of the Gulf of Alaska. The third and fourth quarterly allowances of pollock TAC were combined in the W/C areas into a single seasonal allowance that would be available on September 1. Therefore, the pollock TACs were divided into three seasonal allowances: 25% of TAC available on January 1, 25% of TAC available on June 1, and 50% of TAC available on September 1. This action complemented a regulatory amendment to delay the start of the Bering Sea pollock "B" season from August 15 to September 1 starting in 1996.
46	Amendment 46 removed black and blue rockfishes from the FMP. No additional regulations were promulgated.
47	Withdrawn
48	This amendment was not formally submitted to the Secretary and no regulations have been implemented.
49	Amendment 49 requires all vessels fishing for groundfish in the Gulf of Alaska to retain all pollock and Pacific cod beginning January 1, 1998, and all shallow water flatfish beginning January 1, 2003. It established a 15-percent minimum utilization standard for all at-sea processors.
50	This action authorized the voluntary donation of Pacific halibut taken as bycatch in specified groundfish trawl fisheries off Alaska to economically disadvantaged individuals. Under the prohibited species donation program, NMFS expanded the existing salmon donation program to also authorize distribution by tax-exempt organizations through a NMFS-authorized distributor. The program is limited to dead halibut by trawl catcher vessels and delivered to shoreside processors.
51	As adopted by the Council in June 1998, this amendment reestablishes, without change, the current inshore/offshore allocation regime in the GOA through December 31, 2001. The amendment maintains the current allocation: 100% of the pollock TAC to the inshore component, and 90% of the Pacific cod TAC to the inshore component and 10% to the offshore component.
52	Under a vessel registration program, NMFS would establish criteria to determine which fisheries would require registration. Based on these criteria, NMFS would create a roster of "registration fisheries" that would be announced at the beginning of each year and supplemented as necessary on an inseason basis throughout the year. Criteria for establishing a registration requirement for a fishery could include:

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	<p>1) the size of the TAC amount or PSC limit specified for the fishery relative to the degree of interest in that fishery, (2) a fishery for which the TAC or PSC limit was exceeded by a significant amount in the previous year and the current year’s quota and expected effort are similar, (3) a fishery for which the above two criteria may not apply but an expanded interest has developed inseason, and (4) a “mop-up” fishery.</p> <p>Vessel operators would be required to register with NMFS a certain number of days before beginning directed fishing in a (cont.) registration fishery and penalties would be established for non-compliance.</p>
53	<p>Regulations have not yet been drafted. They will require full retention of DSR in the fixed gear fisheries in GOA Regulatory Area 650: (1) eliminate the maximum retainable bycatch (MRB) limit for DSR; (2) require that all DSR caught by Federally-permitted vessels using fixed gear in the Southeast Outside District be retained, landed, weighed and reported; (3) limit the amount of DSR that may be sold to an amount that is no more than 10 percent of other retained catch; and (4) fishermen may do one or all of the following with amounts of DSR that are in excess of the amount that may be sold: 1. voluntarily surrender to the State of Alaska amounts of DSR that are in excess of the amount that may be sold; 2. retain amounts of DSR that are in excess of the amount that may be sold for personal use; or 3. donate amounts of DSR that are in excess of the amount that may be sold to a state-recognized charity that provides meals for the homeless, the needy, the sick or infirm, or the elderly.</p>
54	<p>Regulations have not yet been drafted.</p>
55	<p>The alternative adopted and approved defined EFH as all habitat within a general distribution for a species life stage, for all information levels and under all stock conditions. A general distribution area is a subset of a species range. For any species listed under the Endangered Species Act, EFH includes all areas identified as "critical habitat". EFH was described in text, tables, and maps. Habitat areas of particular concern were identified as living substrates in shallow and deep waters, and freshwater habitats used by anadromous fish.</p>
56	<p>Amendment 56 revised the ABC and overfishing definitions set under Amendment 44 to be more precautionary. Like Amendment 44, the maximum allowable rates are prescribed through a set of six tiers which are listed below in descending order of preference, corresponding to descending order of information availability. For most tiers, ABC is based on $F_{40\%}$, which is the fishing mortality rate associated with an equilibrium level of spawning per recruit (SPR) equal to 40% of the equilibrium level of spawning per recruit in the absence of any fishing. To further minimize the possibility of catches jeopardizing a stock’s long term productivity, there is a buffer established between ABC and OFL. Amendment 56 modified the OFL definition from $F_{30\%}$ to $F_{35\%}$ for stocks having tiers 2-4 information.</p>
57	<p>The final rule simply extended the Vessel Moratorium Program and the existing moratorium permits through December 31, 1999. The regulation also provided that no person could apply for a new moratorium permit after the original moratorium program expiration date of</p>

Table 2.2. Amendments to the Fishery Management Plan for Groundfish of the Gulf of Alaska.

	December 31, 1998, unless the application was based on a moratorium qualification that was used as a basis for obtaining a moratorium permit issued on or before that date.
58	Five changes were adopted and approved under these amendments: 1) a requirement that the vessel itself would be a specific characteristic of the license and could not be severed (i.e., the license could not be used on any other vessel); 2) license (cont.) designations for the type of gear authorized to harvest LLP groundfish as either "trawl" or "non-trawl" gear (or both); 3) rescission of the Community Development Quota (CDQ) exemption and thus the requirement that CDQ vessels hold a crab or groundfish license; 4) the addition of a crab recency requirement which requires one landing during 1/1/96-2/7/98 in addition to the general license and area endorsement qualifications; and 5) allowance of limited processing (1 mt) for vessels <60' LOA with catcher vessel designations. The most significant addition under these amendments was the recent participation requirement of at least one landing in the king and Tanner crab fisheries between January 1, 1996 and February 7, 1998, which applied only to the base qualifying period under the crab LLP.
59	Amendment 59 would prohibit fishing in an area containing important fish habitat, totaling 3.1 square nautical miles, off Cape Edgecumbe near Sitka, Alaska. This closure would apply to commercial, sport, charter, bycatch and subsistence fisheries for all species of bottomfish and halibut, and boat anchoring to prevent habitat degradation, and to create a groundfish refuge. The area is defined by a square, with lines connecting the following points in a clockwise manner: 56°55.5' N L following, 135°54' N L clockwise 56°57' N Latitude.,135°54' N Longitude; 56°57' N Latitude,135°57' N Longitude; 56°55.5' N Latitude, 135°57' N Longitude.
61	Regulations establish the sector allocations of pollock, define the eligible vessels and processors, define the vessel/processor co-op linkages (which vessels are eligible for which co-ops), make allocations of the pollock TAC among each of the co-ops, and define the sideboard amounts of crab and non-pollock groundfish (based on historical share) that can be harvested and processed by the AFA operators, in both the BSAI and the GOA. Additionally, the regulations extend the GOA inshore/offshore allocations under Amendment 51 through 2004.
65	At the April 2000 meeting, the Council took final action on Harvest Control measures of HAPC Part 1. The Council adopted alternative 2 of the analysis which will add corals and sponges to the prohibited species category. This action will essentially split prohibited species into two types: the first type will continue to allow no retention for halibut, salmon, and crab species, and the second type would include only corals and sponges as prohibited species whose management would be specified in the regulations. The HAPC prohibited species will allow retention, but will prohibit the sale, barter, trade or processing of corals and sponges. Kelp (including rockweed), and mussels would not be subject to any management actions at this time. This action will apply to both the Bering Sea and Gulf of Alaska groundfish fisheries in the EEZ; other fisheries may be considered for HAPC biota protection in the future. The Council will relay concerns to the Alaska Board of Fisheries regarding protection of HAPC biota in state waters.

Table 2.3. Species categories listed in the BSAI FMP.

Target	Prohibited	Other	Forage fish	Nonspecified	
<u>Finfishes</u>					
Pollock	Pacific halibut	Sculpins	Osmeridae (eulachon, capelin, and other smelts)	Eelpouts (Zoarcidae)	
Pacific cod	Pacific herring	Sharks	Myctophidae (lanternfishes)	Poachers (Agonidae) and alligator fish	
Atka mackerel	Pacific salmon	Skates	Bathylagidae (deep-sea smelts)	Snailfish, lumpfishes, lumpsuckers (Cyclopteridae)	
Sablefish	Steelhead		Ammodytidae (Pacific sand lance)	Rattails (Macrounidae)	
Pacific ocean perch	Other rockfishes		Trichodontidae (Pacific sand fish)	Ronquils, searchers (Bathymasteridae)	
Capelin			Pholidae (gunnels)	Lancetfish (Alepisanvidae)	
Yellowfin sole			Stichaeidae (pricklebacks, warbonnets, eelblennys, cockscombs, and shannys)	Prowfish	
Turbots			Gonostomatidae (bristlemouths, lightfishes, and anglemouths)	Hagfish	
Other flatfishes				Lampreys	
<u>Invertebrates</u>					
King crab	Squids	Octopus	Krill (Euphausiacea)	Anemones	Jellyfish
Tanner crab				Starfishes	Tunicates
				Egg cases	Sea cucumber
				Sea mouse	Sea pen
				Sea slug	Isopods
				Sea potato	Barnacles
				Sand dollar	Polychaetes
				Hermit crab	Crinoids
				Mussels	Crab - unidentified
				Sea urchins	Sponge - unidentified

Table 2.4. Final TAC specifications for 1999 and 2000 BSAI groundfish fisheries.

Species	Area	2000 Biomass	2000 OFL	2000 ABC	2000 TAC	1999 TAC	1999 Catch	
Pollock	EBS	7,700,000	1,680,000	1,139,000	1,139,000	992,000	884,133	
	A+B seasons							
	C+D seasons							
Pacific cod	AI	106,000	31,700	23,800	2,000	2,000	1,003	
	Bogostlof	475,000	30,400	22,300	1,000	1,000	21	
	BS/AI	1,300,000	240,000	193,000	193,000	177,000	160,084	
Yellowfin sole	BS/AI	2,820,000	226,000	191,000	123,262	207,980	67,392	
	BS/AI	233,000	42,000	9,300	9,300	9,000		
Greenland turbot	BS			67%	67%	67%	5,315	
	AI			33%	33%	33%	461	
Arrowtooth	BS/AI	785,000	160,000	131,000	131,000	134,354	10,679	
Rock sole	BS/AI	2,070,000	273,000	230,000	134,760	120,000	40,362	
Flathead sole	BS/AI	611,000	90,000	73,500	52,652	77,300	17,777	
Other flatfish	BS/AI	829,000	141,000	117,000	83,813	154,000	15,184	
	EBS	18,000	1,750	1,470	1,470	1,340	628	
Sablefish	AI	33,000	3,090	2,430	2,430	1,380	529	
POP complex	EBS	47,700	3,100	2,600	2,600	1,400	376	
	EBS	8,200	259	194	194	267	217	
True POP	AI	192,000	14,400	12,300	12,300	13,500		
				Eastern	3,120	3,120	3,430	2,416
				Central	3,510	3,510	3,850	2,815
Sharp/Northern Short/Rougheye	AI	115,000	6,870	5,670	5,670	6,220	6,545	
				Western	5,150	5,150	4,230	5,181
Other rockfish	AI	41,500	1,180	885	885	965	474	
	EBS	7,030	492	369	369	369	137	
Atka mackerel	AI	13,000	913	685	685	685	632	
	AI	565,000	119,000	70,800	70,800	66,400	15,893	
Squid	BS/AI	n/a	2,620	16,400	16,400	17,000	15,893	
	BS/AI			24,700	24,700	22,400	21,443	
	BS/AI			29,700	29,700	27,000	15,626	
Other species	BS/AI			1,970	1,970	1,970	413	
	BS/AI	611,000	71,500	31,360	31,360	32,860	18,396	
BS/AI TOTAL		18,580,430	3,203,874	2,260,113	2,000,000	2,000,000	1,223,618	

OFL = Overfishing Level

ABC = Acceptable Biological Level

TAC = Total Allowable Catch

* (A/B):(C/D) season split for CDQ is 45%:55%

** AI pollock TAC is for bycatch only

BS/AI = Bering Sea & Aleutians

BS = Bering Sea

AI = Aleutian Islands

Table 2.5. Species categories listed in the GOA FMP. A fifth category exists for foreign prohibited species, consisting of all of the listed species and other unallocated species.

Target	Prohibited Domestic	Other	Forage fish
Pollock	Pacific halibut	Squid	Osmeridae family (eulachon, capelin, and other smelts)
Pacific cod	Pacific herring	Sculpins	Myctophidae family (lanternfishes)
Atka mackerel	Pacific salmon	Sharks	Bathylagidae family (deep-sea smelts)
Rockfish	Steelhead trout	Skates	Ammodytidae family (Pacific sand lance)
- Other slope	King crab	Octopus	Trichodontidae family (Pacific sand fish)
- Demersal shelf	Tanner crab		Pholidae family (gunnels)
- Pelagic shelf			Stichaeidae family (pricklebacks, warbonnets, eelblennys, cockscombs and shannys)
- Northern rockfish			Gonostomatidae family (bristlemouths, lightfishes, and anglemouths)
- Thornyhead rockfish			Order Euphausiacea (krill)
- Shortraker/rougheye			
- Pacific ocean perch			
Flatfish			
- Deep water			
- Shallow water			
- Flathead sole			
- Rex sole			
- Arrowtooth			
Sablefish			

Table 2.6. Final TAC specifications for 1999 and 2000 GOA groundfish fisheries.

Species	Area	2000		2000		2000		1999		1999
		Biomass	OFL	ABC	TAC	TAC	TAC	Catch		
Pollock	W (61)	588,000	130,760 (EYAK/SEO)	38,350	38,350	23,120	23,387			
	C (62)			22,820	22,820	38,840	38,135			
	C (63)			30,030	30,030	30,520	30,095			
	WYAK			2,340	2,340	2,110	1,759			
EYAK/SEO	6,460	6,460	6,330	4						
Total	616,710	139,370	100,000	100,000	100,920	93,380				
Pacific Cod	W	567,000	102,000	27,500	20,625	23,630	23,154			
	C			43,550	35,165	42,935	44,559			
	E			5,350	4,010	1,270	857			
	Total			76,400	59,800	67,835	68,570			
Flatfish, Deep Water	W	74,600	12,300	280	280	240	22			
	C			2,710	2,710	2,740	1,865			
	WYAK			1,240	1,240	1,720	389			
	EYAK/SEO			1,070	1,070	1,350	9			
Total	74,370	6,980	5,300	6,050	2,285					
Rex Sole	W	74,600	12,300	1,230	1,230	1,190	603			
	C			5,660	5,660	5,490	2,391			
	WYAK			1,540	1,540	850	41			
	EYAK/SEO			1,010	1,010	1,620	22			
Total	74,600	12,300	9,440	9,440	9,150	3,057				
Shallow water Flatfish	W	299,100	45,330	19,510	4,500	4,500	252			
	C			16,400	12,950	12,950	2,282			
	WYAK			790	790	250	6			
	EYAK/SEO			1,160	1,160	1,070	5			
Total	299,100	45,330	19,400	19,400	18,770	2,545				
Flathead Sole	W	207,520	34,210	8,490	2,000	2,000	184			
	C			15,720	5,000	5,000	680			
	WYAK			1,440	1,440	1,270	16			
	EYAK/SEO			620	620	770	11			
Total	207,520	34,210	26,270	9,060	9,040	891				
Arrowtooth	W	1,571,670	173,910	16,160	5,000	5,000	3,656			
	C			97,710	25,000	25,000	11,787			
	WYAK			23,770	2,500	2,500	383			
	EYAK/SEO			7,720	2,500	2,500	236			
Total	1,571,670	173,910	145,360	35,000	35,000	16,062				
Sablefish	W	169,000	16,660	1,840	1,840	1,820	1,487			
	C			5,730	5,730	5,590	5,828			
	E/WYAK			5,760	2,207	2,090	1,704			
	EYAK/SEO			3,553	3,553	3,200	3,080			
Total	169,000	16,660	13,300	13,300	12,700	12,099				
Other slope rockfish	W	102,510	6,390	20	20	20	40			
	C			740	740	650	615			
	WYAK			250	250	470	122			
	EYAK/SEO			3,890	3,890	4,130	12			
Total	102,510	6,390	4,900	4,900	5,270	789				
Northern rockfish	W	85,360	7,510	630	630	840	573			
	C			4,490	4,490	4,150	4,825			
	E			0	0	0	0			
	Total			85,360	7,510	5,120	4,990	5,398		
Pacific Ocean Perch	W	200,310	15,390	1,460	1,240	1,850	1,935			
	C			10,930	9,240	6,760	7,914			
	WYAK			840	840	820	627			
	EYAK/SEO			3,000	1,700	3,160	0			
Total	200,310	15,390	13,020	13,020	12,590	10,476				

Table 2.6. cont.

Species	Area	2000 Biomass	2000 OFL	2000 ABC	2000 TAC	1999 TAC	1999 Catch
Shortraker/Roughye	W			210	210	160	194
	C			930	930	970	577
	E			590	590	460	531
	Total	70,880	2,510	1,730	1,730	1,590	1,302
Pelagic shelf rockfish	W			550	550	530	130
	C			4,080	4,080	3,370	3,835
	WYAK			580	580	740	672
	EYAK/SEO			770	770	240	20
	Total	66,440	9,040	5,980	5,980	4,880	4,657
Demersal shelf rockfish		15,100	420	340	340	560	262
Atka Mackerel	Gulfwide	unknown	6,200	600	600	600	262
Thornyhead	W			430	430	260	282
	C			990	990	700	582
	E			940	940	1,030	410
	Total	52,950	2,820	2,360	2,360	1,990	1,274
Other Species	Gulfwide	NA	NA	NA	14,270	14,600	3,735
GULF OF ALASKA	TOTAL	4,173,520	581,040	431,410	299,650	306,535	227,044

WYAK = Western Yakutat

EYAK = Eastern Yakutat

SEO = Southeast Outside

OFL = Overfishing Level

ABC = Acceptable Biological Catch

TAC = Total Allowable Catch

1999 Catch as of 11/6/99

Table 2.7. Survey CVs by species/species groups. (EBS = eastern Bering Sea, AI = Aleutian Islands.)

Species or species group	FMP/Area	Survey type	Survey CV	Assessment method	ABC/OFL tier
Alaska Plaice	BSAI	Bottom trawl	12%	AD model builder	3a
Arrowtooth flounder	BSAI	Bottom trawl	12%	Stock synthesis	3a
Arrowtooth flounder	GOA	Bottom trawl	9%	AD model builder	3a
Atka mackerel	BSAI	Bottom trawl	38%	Stock synthesis	3a
Deepwater flatfish	GOA	Bottom trawl	9%	Survey index	--
Flathead sole	GOA	Bottom trawl	12%	AD model builder	5
Flathead sole	BSAI	Bottom trawl	11%	Stock synthesis	3a
Greenland turbot	BSAI	Bottom trawl	31%	Stock synthesis	3a
Northern rockfish	GOA	Bottom trawl	41%	Survey index	4
Octopus	GOA	Bottom trawl	48%	Survey index	5
Other red rockfish	EBS	Bottom trawl	33%	Survey index	5
Other rockfish	AI	Bottom trawl	18%	Survey index	5
Other rockfish	EBS	Bottom trawl	15%	Survey index	5
Other slope rockfish	GOA	Bottom trawl	21%	Survey index	--
Other flatfish	BSAI	Bottom trawl	26%	Survey index	3a
Pacific ocean perch	BSAI	Bottom trawl	35%	Stock synthesis	3b
Pacific ocean perch	GOA	Bottom trawl	30%	Stock synthesis	3b
Pacific cod	BSAI	Bottom trawl	9%	Stock synthesis	3b
Pacific cod	GOA	Bottom trawl	15%	Stock synthesis	3a
Pacific ocean perch	BSAI	Bottom trawl	21%	Stock synthesis	3b
Pelagic rockfish	GOA	Bottom trawl	39%	Survey index	4
Pollock	AI	Bottom trawl	19%	Survey index	5
Pollock	GOA	Bottom trawl/EIT	19%	AD model builder	3b
Pollock	Southeast	Bottom trawl	33%	Survey index	--
Pollock	EBS	Bottom trawl/EIT	23%	AD model builder	1a
Rex sole	GOA	Bottom trawl	9%	Survey index	5
Rock sole	BSAI	Bottom trawl	8%	AD model builder	3a
Sablefish	GOA	Longline	10%	AD model builder	3b
Sculpins	GOA	Bottom trawl	15%	Survey index	5
Shallow flatfish	GOA	Bottom trawl	15%	Survey index	5
Sharks	GOA	Bottom trawl	26%	Survey index	5
Sharpchin/Northern	BSAI	Bottom trawl	28%	Survey index	5
Shortraker/Rougheye	GOA	Bottom trawl	15%	Survey index	--
Shortraker/Rougheye	BSAI	Bottom trawl	32%	Survey index	5
Shortspine thornyhead	GOA	Bottom trawl	13%	Survey index	3a
Skates	GOA	Bottom trawl	13%	Survey index	5
Smeelts	GOA	Bottom trawl	14%	Survey index	5
Squid	GOA	Bottom trawl	17%	Survey index	6
Yellowfin sole	BSAI	Bottom trawl	10%	AD model builder	3a

Table 2.8. Maximum retainable incidental catch amounts (expressed as percentages) for the BSAI. (na = not applicable)

Target species	Incidental catch species														
	Pollock	Pacific cod	Atka mackerel	Arrowtooth	Yellowfin sole	Other flatfish	Rocksole	Flathead Sole	Greenland turbot	Sablefish	Raker/rougheye (AI)	Aggregated rockfish	Squid	Forage fish	Other species
Pollock	na	20	20	35	20	20	20	20	1	1	2	5	20	2	20
Pacific cod	20	na	20	35	20	20	20	20	1	1	2	5	20	2	20
Atka mackerel	20	20	na	35	20	20	20	20	1	1	2	5	20	2	20
Arrowtooth	0	0	0	na	0	0	0	0	0	0	0	0	0	2	0
Yellowfin sole	20	20	20	35	na	35	35	35	1	1	2	5	20	2	20
Other flatfish	20	20	20	35	35	na	35	35	1	1	2	5	20	2	20
Rocksole	20	20	20	35	35	35	na	35	1	1	2	5	20	2	20
Flathead sole	20	20	20	35	35	35	35	na	35	15	7	15	20	2	20
Greenland turbot	20	20	20	35	20	20	20	20	na	15	7	15	20	2	20
Sablefish	20	20	20	35	20	20	20	20	35	na	7	15	20	2	20
Other rockfish	20	20	20	35	20	20	20	20	35	15	7	15	20	2	20
Other red rockfish BS	20	20	20	35	20	20	20	20	35	15	na	15	20	2	20
Pacific Ocean perch	20	20	20	35	20	20	20	20	35	15	7	15	20	2	20
Sharpchin/Northern-AI	20	20	20	35	20	20	20	20	35	15	7	15	20	2	20
Shortraker/Rougheve-AI	20	20	20	35	20	20	20	20	35	15	na	15	20	2	20
Squid	20	20	20	35	20	20	20	20	1	1	2	5	na	2	20
Other species	20	20	20	35	20	20	20	20	1	1	2	5	20	2	na
Aggregated amount	20	20	20	35	20	20	20	20	1	1	2	5	20	2	20

Table 2.9. Maximum retainable incidental catch amounts (expressed as percentages) for the GOA. (na = not applicable)

Target species	Incidental catch species													
	Pollock	Pacific cod	Deep flatfish	Rex sole	Flathead sole	Shallow flatfish	Arrowtooth	Sablefish	Aggregated rockfish	Raker/rougheye, eastern GOA	Demersal shelf rockfish/SEO	Atka mackerel	Aggregated forage fish	Other species
Pollock	na	20	20	20	20	20	35	1	5	(7)	10	20	2	20
Pacific cod	20	na	20	20	20	20	35	1	5	(7)	10	20	2	20
Deep flatfish	20	20	na	20	20	20	35	7	15	7	1	20	2	20
Rex sole	20	20	20	na	20	20	35	7	15	7	1	20	2	20
Flathead sole	20	20	20	20	na	20	35	7	15	7	1	20	2	20
Shallow flatfish	20	20	20	20	20	na	35	1	5	(7)	10	20	2	20
Arrowtooth	5	5	0	0	0	0	na	0	0	0	0	0	2	0
Sablefish	20	20	20	20	20	20	35		15	7	1	20	2	20
Pacific ocean perch	20	20	20	20	20	20	35	7	15	7	1	20	2	20
Shortraker/rougheye	20	20	20	20	20	20	35	7	15	na	1	20	2	20
Other rockfish	20	20	20	20	20	20	35	7	15	7	1	20	2	20
Northern rockfish	20	20	20	20	20	20	35	7	15	7	1	20	2	20
Pelagic rockfish	20	20	20	20	20	20	35	7	15	7	1	20	2	20
DSR-SEO	20	20	20	20	20	20	35	7	15	7	na	20	2	20
Thornyhead	20	20	20	20	20	20	35	7	15	7	1	20	2	20
Atka mackerel	20	20	20	20	20	20	35	1	5	(7)	10	na	2	20
Other species	20	20	20	20	20	20	35	1	5	(7)	10	20	2	na
Aggregated amount of non-groundfish species	20	20	20	20	20	20	35	1	5	(7)	10	20	2	20

Table 2.10. Regulatory allocations of 2000 TAC specifications in the BSAI.

Species ¹	Gear	Season	Other Allocations and Reserves
Pollock ²	None	Season dates (outside SCA) A season: 1/20 to 4/1 B season: 4/1 to 6/10 C season: 6/10 to 8/20 D season: 8/20 to Nov 1	%TAC 30% 10% 30% 30% CDQ Incidental bycatch Of the remaining TAC: Inshore Mothership Catcher/proc. 10% 5% 50% 10% 40%
Pacific cod	Jig Hook-&-line/pot Trawl	2% 51% 47%	[71%] ³ [0%] [29%]
		1/1 to 4/30--First allowance 5/1 to 8/31--Second allowance 9/1 to 12/31--Third allowance (hook-and-line/pot allocation only) Proportion recommended annually by Council	Trawl allocation is split: Catcher vessels Catcher/processors 50% 50%
Sablefish	Bering Sea Hook&line/pot ⁴ Trawl Aleutian Islands Hook&line/pot ⁴ Trawl	50% 50% 75% 25%	20% of hook-&-line/pot allocation to CDQ reserve 7.5% of trawl allocation to CDQ reserve
Atka mackerel	Jig gear - up to 2% of eastern AI and Bering Sea TAC. Amount recommended annually by Council	Season dates Trawl A season: 1/20 to 4/15 Trawl B season: 9/1 to 11/1 1/1 to 12/31--for non-trawl gear	Trawl allocation split A season 50% B season 50% 7.5% of TAC to CDQ reserve
Greenland turbot	None	5/1 to 12/31	7.5% of TAC to CDQ reserve
All other Species	None	1/20 to 12/31--for trawl gear 1/1 to 12/31--for non-trawl gear	7.5% of TAC to CDQ reserve

Notes: 1 = Except for pollock and sablefish, 25 % of each initial TAC (TAC minus reserves) is made available January 1 under interim specifications. The remainder is made available when the final specifications suppedede the interim specifications, generally in February or March.

2 = AFA Allocations.

A. Pollock CDQ - effective January 1, 1999, 10 percent of the total allowable catch of pollock in the Bering Sea and Aleutian Islands Management Area shall be allocated as a directed fishing allowance to the western Alaska CDQ program .

B. Inshore/Offshore. - effective January 1, 1999, the remainder of the pollock total allowable catch in the Bering Sea and Aleutian Islands Management Area, after the subtraction of the allocation under subsection (a) and the subtraction of allowances for the incidental catch of pollock by vessels harvesting other groundfish species (including under the western Alaska community development quota program) shall be allocated as directed fishing allowances as follows:

(1) 50% to catcher vessels for processing by the inshore component;

(2) 40% to catcher/processors and catcher vessels for processing by catcher/processors in the offshore component; and

(3) 10% to catcher vessels for processing by motherships in the offshore component.

3 = Percentages in brackets [xx%] are 2000 examples; these percentages may vary from year to year.

4 = None of the hook-&-line/pot allocation of sablefish is made available under the interim specifications. Thus, hook-&-line/pot sablefish may not open until the final specifications are filed.

Table 2.11. Regulatory allocations of 2000 TAC specifications in the GOA.

Species	Gear	Season	Other Allocations and Reserves
Pollock	None	<u>Western and central GOA:</u> 1/20 to 3/1--1st allowance	Inshore component 100% Offshore (bycatch)
		3/15 to 5/31--2nd allowance	15%
		8/20 to 9/15--3rd allowance...	30%
		10/1 to 11/1--4th allowance..	25%
		<u>Eastern GOA:</u> 1/1 to 12/31	20% of TAC to initial reserve
Sablefish	Eastern Area ¹ Trawl gear --for trawl gear Hook-&-line gear --for non-trawl gear	1/20 to 12/31 § 679.23(c)	None
		1/1 to 12/31 § 679.23(a)	
	<u>Central and Western Area</u> Trawl gear Hook-&-line gear		
		20% 80%	
Pacific cod	--Trawl gear --Non-trawl gear	1/20 to 12/31	Inshore component 90% Offshore component 10%
		1/1 to 12/31	
			20% of TAC to initial reserve
Flatfish and "other" ² species ²	--Trawl gear --Non-trawl gear	1/20 to 12/31	20% of TAC to initial reserve
		1/1 to 12/31	
Rockfish ³	--Trawl gear --Non-trawl gear	7/1 to 12/31 1/1 to 12/31	None
All other species	--Trawl gear --Non-trawl gear	1/20 to 12/31 1/1 to 12/31	None

Notes: 1 = The trawl allocation of sablefish in the eastern regulatory area may be used only for bycatch purposes.
 2 = Flatfish includes Dover sole, deep sea sole, sand sole, Alaska plaice, English sole, starry flounder, butter sole, and rex sole.
 3 = Rockfish are any species of Sebastes or Sebastolobus except the black rockfish and the blue rockfish.

Table 2.12a. Steller sea lion protection areas in the Bering Sea subarea .

Bering Sea Subarea Management Area/Island/Site	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Directed fishing for pollock prohibited within. . .(nm)		Trawling prohibited within (nm)	
	Latitude (N)	Longitude (W)					Nov. 1 - Jun. 1	Jun. 1 - Nov. 1	Jan. 1 - Apr. 15	Year-round
St. Lawrence I./S Punuk I.	63 04.00 N	168 51.00 W	H			20				
Hall I.	60 37.00 N	173 00.00 W	H			20				
St Paul I./Sea Lion Rock	57 06.00 N	170 17.50 W	H			20				
St Paul I./NE Pt.	57 15.00 N	170 06.50 W	H			20				
Walrus I.	57 11.00 N	169 56.00 W	R	Whole Island	3	20	20	20		10
St. George I./Dalnoi Pt.	56 36.00 N	169 46.00 W	H			20				
St. George I./S Rookery	56 33.50 N	169 40.00 W	H			20				
Cape Newenham	58 39.00 N	162 10.50 W	H			20				
Uliaga	53 04.00 N	169 47.00 W						20		
	53 05.00 N	169 46.00 W								
Chuginadak	52 46.70 N	169 41.90 W	H			20		20		
Kagamil	53 02.10 N	169 41.00 W	H			20		20		
Samalga	52 46.00 N	169 15.00 W						20		
Adugak I.	52 54.70 N	169 10.50 W	R	Whole Island	3	20	20	20		10
Umnak I./Cape Aslik	53 25.00 N	168 24.50 W	H			20	20	20		
Ogchul I.	52 59.71 N	168 24.24 W	R	Whole Island	3	20	20	20		10
Bogoslof I./Fire Island	53 55.69 N	168 02.05 W	R	Whole Island	3	20	20	20		10
Emerald I.	53 17.50 N	167 51.50 W	H			20		20		
Unalaska/Cape Izigan	53 13.64 N	167 39.37 W					20	20		
Unalaska/Bishop Pt	53 58.40 N	166 57.50 W					20	20		
Unalaska I./Cape Sedanka	53 50.50 N	166 05.00 W	H			20				
Akutan I./Reef-lava	54 08.10 N	166 06.19 W	H			20	20	20		
	54 09.10 N	166 05.50 W								
Old Man Rocks	53 52.20 N	166 04.90 W	H			20	20	20		
Akutan I./Cape Morgan	54 03.39 N	165 59.65 W	R	SW corner,	3	20	20	20	20	10
	54 03.70 N	166 03.68 W		Cape Morgan						

Table 2.12a. (cont.)

Bering Sea Subarea Management Area/Island/Site	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Directed fishing for pollock prohibited within. . .(nm)		Trawling prohibited within (nm)	
	Latitude (N)	Longitude (W)					Nov. 1 - Jun. 1	Jun. 1 - Nov. 1	Jan. 1 - Apr. 15	Year-round
Akun I./Billings Head	54 17.62 N 54 17.57 N	165 32.06 W 165 31.71 W	R	Billings Head Bight.	3	20	20	20	20	10
Rootok	54 03.90 N 54 02.90 N	165 31.90 W 165 29.50 W						20		
Tanginak I.	54 12.00 N	165 19.40 W	H			20	20			
Tigalda/Rocks NE	54 09.60 N 54 09.12 N	164 59.00 W 164 57.18 W	H			20	20	20		
Unimak/Cape Sarichef	54 34.30 N	164 56.80 W					20	20		
Aiktak	54 10.99 N	164 51.15 W					20			
Ugamak I.	54 13.50 N 54 12.80 N	164 47.50 W 164 47.50 W	R	Eastern End	3	20	20	20	20	10
Round I.	54 12.05 N	164 46.60 W	H			20		20		
Sea Lion Rock (Amak)	55 27.82 N	163 12.10 W	R	Whole Island	3	20	20	20	20	10
Amak I. and rocks	55 24.20 N 55 26.15 N	163 09.60 W 163 08.50 W	H			20	20	20		

¹ Where two sets of coordinates are given, the baseline extends in a clock-wise direction from the first set of geographic coordinates along the shoreline at mean lower-low water to the second set of coordinates. Where only one set of coordinates is listed, that location is the base point.

² Listed rookery and haulout sites under the ESA designated in this table are defined at 50 CFR 226.202. Three nm no transit zones and other protections for listed rookery sites listed in this table are defined at 50 CFR 223.202. Sites in this table that do not have an R or H description have not been listed under the ESA as a rookery or haulout with the appropriate critical habitat designation. However, these sites are used as haulouts by Steller sea lions and have been determined by NMFS to be of special importance to the endangered western population of Steller sea lions.

Table 2.12b. Steller sea lion protection areas in the Aleutian Islands subarea.

Aleutian Islands Area Management Area/Island/Site	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Trawling prohibited within . . . (nm) Year-round
	Latitude (N)	Longitude (W,E)					
Attu I./Cape Wrangell	52 54.60 N	172 27.90 E	R	S. Quadrant	3	20	10
	52 55.40 N	172 27.20 E					
Agattu I./Gillon Pt	52 24.13 N	173 21.31 E	R	Gillion Point	3	20	10
Attu I./Chirikof Pt.	52 49.75 N	173 26.00 E	H			20	
Agattu I./Cape Sabek	52 22.50 N	173 43.30 E	R	Cape Sabek	3	20	10
	52 21.80 N	173 41.40 E					
Alaid I.	52 46.50 N	173 51.50 E	H			20	
	52 45.00 N	173 56.50 E					
Shemya I.	52 44.00 N	174 08.70 E	H			20	
Buldir I.	52 20.25 N	175 54.03 E	R	SE side of Island	3	20	10
	52 20.38 N	175 53.85 E					
Kiska I./Cape St. Stephen	51 52.50 N	177 12.70 E	R	Cape St. Stephen	3	20	10
	51 53.50 N	177 12.00 E					
Kiska I./Sobaka & Vega	51 49.50 N	177 19.00 E	H			20	
	51 48.50 N	177 20.50 E					
Kiska I./Lief Cove	51 57.16 N	177 20.41 E	R	W. central, Lief Cove	3	20	10
	51 57.24 N	177 20.53 E					
Kiska I./Sirius Pt.	52 08.50 N	177 36.50 E	H			20	
Tanadak I. (Kiska)	51 56.80 N	177 46.80 E	H			20	
Segula I.	51 59.90 N	178 05.80 E	H			20	
	52 03.06 N	178 08.80 E					
Ayugadak Point	51 45.36 N	178 24.30 E	R	SE coast of Rat Island	3	20	10
Little Sitkin I.	51 59.30 N	178 29.80 E	H			20	
Amchitka I./Column Rocks	51 32.32 N	178 49.28 E	R	Column Rocks	3	20	10
Amchitka I./East Cape	51 22.26 N	179 27.93 E	R	East Cape	3	20	10
	51 22.00 N	179 27.00 E					
Semisopochnoi/Petrel Pt.	52 01.40 N	179 36.90 E	R	N quadrant, Petrel Point	3	20	10
	52 01.50 N	179 39.00 E					
Semisopochnoi I./Pochnoi Pt.	51 57.30 N	179 46.00 E	R	E quadrant, Pochnoi Pt.	3	20	10
Amatignak I.	51 13.00 N	179 07.80 W	H	Nitrof Point		20	
Unalga & Dinkum Rocks	51 33.67 N	179 04.25 W	H			20	
	51 35.09 N	179 03.66 W					
Ulak I.	51 18.90 N	178 58.90 W	R	SE corner, Hasgox Point	3	20	10
	51 18.70 N	178 59.60 W					
Kavalga I.	51 34.50 N	178 51.73 W	H			20	
	51 34.50 N	178 49.50 W					

Table 2.12b. (cont.)

Aleutian Islands Area Management Area/Island/Site	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Trawling prohibited within. . . (nm) Year-round
	Latitude (N)	Longitude (W,E)					
Tag I.	51 33.50 N	178 34.50 W	R	Whole Island	3	20	10
Ugidak I.	51 34.95 N	178 30.45 W	H			20	
Gramp Rock	51 28.87 N	178 20.58 W	R	Whole Island	3	20	10
Tanaga I.	51 55.00 N	177 58.50 W	H	Bumpy Point		20	
	51 55.00 N	177 57.10 W					
Bobrof I.	51 54.00 N	177 27.00 W	H			20	
Kanaga I./Ship Rock	51 46.70 N	177 20.72 W	H			20	
Kanaga I./North Cape	51 56.50 N	177 09.00 W	H			20	
Adak I.	51 35.50 N	176 57.10 W	R	Cape Yakak-Lake Point	3	20	10
	51 37.40 N	176 59.60 W					
Little Tanaga Strait	51 49.09 N	176 13.90 W	H			20	
Great Sitkin I.	52 06.00 N	176 10.50 W	H			20	
	52 07.00 N	176 07.00 W					
Anagaksik I.	51 50.86 N	175 53.00 W	H			20	
Kasatochi I.	52 11.11 N	175 31.00 W	R	North half of Island	3	20	10
Atka I.	52 24.20 N	174 17.80 W	H	North Cape		20	
Amlia I./Sviech. Harbor	52 01.80 N	173 23.90 W	H			20	
Sagigik I.	52 00.50 N	173 09.30 W	H			20	
Amlia I./East	52 05.70 N	172 59.00 W	H			20	
	52 05.75 N	172 57.50 W					
Tanadak I. (Amlia)	52 04.20 N	172 57.60 W	H			20	
Agligadak I.	52 06.09 N	172 54.23 W	R	Whole Island	3	20	20
Seguam I./Saddleridge	52 21.05 N	172 34.40 W	R	N coast, Saddleridge Point	3	20	20
	52 21.02 N	172 33.60 W					
Seguam I./Finch Pt.	52 23.40 N	172 27.70 W	H			20	
	52 23.25 N	172 24.30 W					
Seguam I./South Side	52 21.60 N	172 19.30 W	H	Wharf Pt. to Turf Pt.		20	
	52 15.55 N	172 31.22 W					
Amukta I. & Rocks	52 27.25 N	171 17.90 W	H			20	
Chagulak I.	52 34.00 N	171 10.50 W	H			20	
Yunaska I.	52 41.40 N	170 36.35 W	R	NE end	3	20	10

¹ Where two sets of coordinates are given, the baseline extends in a clock-wise direction from the first set of geographic coordinates along the shoreline at mean lower-low water to the second set of coordinates. Where only one set of coordinates is listed, that location is the base point.

² Listed rookery and haulout sites under the ESA designated in this table are defined at 50 CFR 226.202. Three nm no transit zones and other protections for listed rookery sites listed in this table are defined at 50 CFR 223.202. Sites in this table that do not have an R or H description have not been listed under the ESA as a rookery or haulout with the appropriate critical habitat designation. However, these sites are used as haulouts by Steller sea lions and have been determined by NMFS to be of special importance to the endangered western population of Steller sea lions.

Table 2.12c. Steller sea lion protection areas in the Gulf of Alaska.

Gulf of Alaska Management Area/Island/Site ¹	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Directed fishing for pollock prohibited within... (nm)		Trawling prohibited within ... (nm) Year-round
	Latitude (N)	Longitude (W)					Nov. 1 - Jun. 1	Jun. 1 - Nov. 1	
Bird I.	54 40.00 N	163 17.15 W	H			20	10	10	
South Rocks	54 18.14 N	162 41.25 W	H			20	10	10	
Clubbing Rocks (S)	54 41.98 N	162 26.74 W	R	Whole Island	3	20	10	10	10
Clubbing Rocks (N)	54 42.75 N	162 26.72 W	R	Whole Island	3	20	10	10	10
Caton I.	54 22.70 N	162 21.30 W	H			20			
Pinnacle Rock	54 46.06 N	161 45.85 W	R	Whole Island	3	20	10	10	10
Sushilnoi Rocks	54 49.30 N	161 42.73 W						10	
Olga Rocks	55 00.45 N	161 29.81 W					10	10	
	54 59.09 N	161 30.89 W							
Jude I.	55 15.75 N	161 06.27 W	H			20	10	10	
Sea Lion Rocks (Shumagins) ³	55 04.70 N	160 31.04 W	H			20	10	10	
Nagai/Mountain Pt.	54 54.20 N	160 15.40 W	H			20			
	54 56.00 N	160 15.00 W							
The Whaleback	55 16.82 N	160 05.04 W	H			20	10	10	
Chernabura I.	54 45.18 N	159 32.99 W	R	SE corner	3	20	10	10	10
	54 45.86 N	159 35.74 W							
Castle Rock	55 16.47 N	159 29.77 W	H			20		10	
Atkins I.	55 03.20 N	159 17.40 W	R	Whole Island	3	20	10	10	10
Spitz I.	55 46.60 N	158 53.90 W	H			20		10	
Mitrofanina	55 50.20 N	158 41.90 W					10	10	
Kak	56 17.30 N	157 50.10 W						10	
Lighthouse Rocks	55 46.79 N	157 24.89 W	H			20	10	10	
	Sutwik I.	56 31.05 N	157 20.47 W	H		20		10	
Chowiet I.	56 00.54 N	156 41.42 W	R	S quadrant	3	20	10	10	10
	56 00.30 N	156 41.60 W							
Nagai Rocks	55 49.80 N	155 47.50 W	H			20	10	10	
Chirikof I.	55 46.50 N	155 39.50 W	R	S quadrant	3	20	10	10	10
	55 46.44 N	155 43.46 W							
Puale Bay	57 40.60 N	155 23.10 W	H			20	10	10	

Table 2.12c. (cont.)

Gulf of Alaska Management Area/Island/Site ¹	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Directed fishing for pollock prohibited within... (nm)		Trawling prohibited within ... (nm) Year-round
	Latitude (N)	Longitude (W)					Nov. 1 - Jun. 1	Jun. 1 - Nov. 1	
Kodiak/Cape Ikolik	57 17.20 N	154 47.50 W	H			20	10		
Takli I.	58 01.75 N	154 31.25 W	H			20		10	
Cape Kuliak	58 08.00 N	154 12.50 W	H			20			
Cape Gull	58 11.50 N	154 09.60 W	H			20		10	
	58 12.50 N	154 10.50 W							
Kodiak/Cape Ugat	57 52.41 N	153 50.97 W	H			20	10	10	
Sitkinak/Cape Sitkinak	56 34.30 N	153 50.96 W	H			20	10	10	
Shakun Rock	58 32.80 N	153 41.50 W	H			20	10	10	
Twoheaded I.	56 54.50 N	153 32.75 W	H			20	10	10	
	56 53.90 N	153 33.74 W							
Cape Douglas (Shaw I.)	59 00.00 N	153 22.50 W						10	
Kodiak/Cape Barnabas	57 10.20 N	152 53.05 W	H			20	10	10	
Kodiak/Gull Point	57 21.45 N	152 36.30 W	H			20	10	10	
Latax Rocks	58 40.10 N	152 31.30 W	H			20	10	10	
Ushagat I./SW	58 54.75 N	152 22.20 W	H			20		10	
Ugak I.	57 23.60 N	152 17.50 W	H			20		10	
	57 21.90 N	152 17.40 W							
Sea Otter I.	58 31.15 N	152 13.30 W	H			20	10	10	
Long I.	57 46.82 N	152 12.90 W	H			20	10		
Sud I.	58 54.00 N	152 12.50 W	H			20			
Kodiak/Cape Chiniak	57 37.90 N	152 08.25 W	H			20	10	10	
Sugarloaf I.	58 53.25 N	152 02.40 W	R	Whole Island	3	20	10	10	10
Sea Lion Rocks (Marmot)	58 20.53 N	151 48.83 W	H			20	10	10	
Marmot I.	58 13.65 N	151 47.75 W	R	SE quadrant	3	20	10	10	10
	58 09.90 N	151 52.06 W							
Nagahut Rocks	59 06.00 N	151 46.30 W	H			20			
Perl	59 05.75 N	151 39.75 W					10	10	

Table 2.12c. (cont.)

Gulf of Alaska Management Area/Island/Site ¹	Boundaries ¹		ESA Listed Rookery (R) or Haulout (H) ²	Notes	No transit zone (nm) ²	Critical habitat area (nm) ²	Directed fishing for pollock prohibited within... (nm)		Trawling prohibited within ... (nm) Year-round
	Latitude (N)	Longitude (W)					Nov. 1 - Jun. 1	Jun. 1 - Nov. 1	
Gore Point	59 12.00 N	150 58.00 W	H			20			
Outer (Pye) I.	59 20.50 N	150 23.00 W	R	S quadrant	3	20	10	10	10
	59 21.00 N	150 24.50 W							
Steep Point	59 29.05 N	150 15.40 W						10	
Chiswell Islands	59 36.00 N	149 34.00 W	H			20	10	10	
Rugged Island	59 49.80 N	149 23.30 W					10		
	59 51.00 N	149 25.30 W							
Point Elrington ⁴	59 56.00 N	148 15.20 W	H			20			
Perry I.	60 44.00 N	147 54.60 W	H			20			
The Needle ⁴	60 06.64 N	147 36.17 W	H			20			
Point Eleanor	60 35.00 N	147 34.00 W	H			20			
Wooded I. (Fish I.)	59 52.90 N	147 20.65 W	R		(⁵)	20	10	10	
Glacier Island	60 51.30 N	147 14.50 W					10	10	
Seal Rocks	60 09.78 N	146 50.30 W	R,H		3	20	10	10	
Cape Hinchinbrook	60 14.00 N	146 38.50 W						10	
Middleton I.	59 28.30 N	146 18.80 W	H			20			
Hook Point	60 20.00 N	146 15.60 W	H			20		10	
Cape St. Elias	59 47.50 N	144 36.20 W	H			20	10	10	
Cape Fairweather ⁶	58 47.50 N	137 56.30 W	H						
Graves Rock ⁶	58 14.30 N	136 45.40 W	H						

¹ Where two sets of coordinates are given, the baseline extends in a clock-wise direction from the first set of geographic coordinates along the shoreline at mean lower-low water to the second set of coordinates. Where only one set of coordinates is listed, that location is the base point.

² Listed rookery and haulout sites under the ESA designated in this table are defined at 50 CFR 226.202. Three nm no transit zones and other protections for listed rookery sites listed in this table are defined at 50 CFR 223.202. Sites in this table that do not have an R or H description have not been listed under the ESA as a rookery or haulout with the appropriate critical habitat designation. However, these sites are used as haulouts by Steller sea lions and have been determined by NMFS to be of special importance to the endangered western population of Steller sea lions.

³ Vessels less than or equal to 60 ft (18.3 m) LOA are exempt from the 10 nm closure at Sea Lion Rocks (Shumagins).

⁴ Restrictions at Point Elrington and The Needle will be considered by the Alaska Board of Fisheries because these areas fall completely within the State of Alaska management area of Prince William Sound.

⁵ Wooded Island does not have a 3 nm no trawl zone described under 50 CFR 223.202, but is listed as a major rookery under 50 CFR part 226.202.

⁶ Cape Fairweather and Graves Rock are east of 144 degrees west longitude and therefore does not include a 20 nm aquatic critical habitat zone (50 CFR part 226.202(a)).

Table 4.1. Life history table for Steller sea lions based on Calkins and Pitcher (1982) and York (1994). (From York 1994.)

Ages		Calkins-Pitcher life table				York life table		
From	To	Fecundity	Cum. survival	Annual survival	Percent at age	Cum. survival	Annual survival	Percent at age
0	1	0.000	1.000	0.776	16.676	1.000	0.782	16.251
1	2	0.000	0.776	0.776	12.546	0.782	0.782	12.709
2	3	0.000	0.603	0.776	9.438	0.612	0.782	9.938
3	4	0.105	0.468	0.868	7.100	0.478	0.930	7.772
4	5	0.267	0.406	0.879	6.163	0.445	0.909	7.228
5	6	0.286	0.357	0.888	5.417	0.404	0.895	6.570
6	7	0.315	0.317	0.893	4.811	0.362	0.884	5.880
7	8	0.315	0.283	0.898	4.296	0.320	0.875	5.198
8	9	0.315	0.254	0.874	3.857	0.280	0.867	4.548
9	10	0.315	0.222	0.899	3.372	0.242	0.859	3.943
10	11	0.315	0.200	0.893	3.031	0.208	0.853	3.338
11	12	0.315	0.178	0.896	2.707	0.178	0.847	2.889
12	13	0.315	0.160	0.895	2.425	0.150	0.841	2.447
13	31	0.315	0.160	0.895	15.99	0.150	p(x)d	11.239

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
<p>1901-1958: AK,BC, and OR, Summer/Winter, (n=19). Reports a range of fish and cephalopods for 12 time/area studies from AK,BC, and OR. For his BC study: (in order of FO) included squid, herring, rockfish, octopus, salmon, skate, and hake. For other studies in his table: rockfish, perch, herring, skate, shark, squid, octopus, lamprey, salmon, "cod", "bass", mussels, clam, crab, dogfish, flatfish, and sardines. Pike (1958)</p>	<p>1946: CGOA, Summer, (n=7). 3 Collected from Barren Is. Contained pollock, starry flounder, tom cod, arrowtooth flounder, halibut, and octopus. 2 from Chiswell Is. Contained 100% salmon and 2 from Kodiak Is. Contained pollock and arrowtooth flounder(Imler & Sarber 1947)</p>
<p>1946: SEAK, Summer, (n=15). 8 sampled in SEAK; 7 fed principally on pollock, and 1 contained a skate and an octopus (Imler & Sarber 1947)</p>	<p>1950: Kuril Islands, Russia. Observation only: a sea lion feeding on octopus. (Sleptsov 1950 in Spalding 1964)</p>
<p>1956-1963: BC, Winter-Fall; feed primarily at night (n=269 or 393 sampled). Suggests animals prey mainly on one item per feeding period. Some seen feeding at surface on lingcod, rockfish, salmon, or halibut (n=8). Consumption of herring and salmon by sea lions, fur seals, and harbor seals estimated about 2% to 4% of commercial catch. Prey (in order of FO): octopus, rockfish, herring, whiting, salmon, dogfish, squid, hake, flatfish, clam, ratfish, shrimp, sandlance, graycod, lingcod, and single occurrences of lamprey, skate, eulachon, halibut, and mackereljack. (Spalding 1964)</p>	<p>1949, 1951: EBS, St. Paul, Summer, (n=3) 1 sea lion stomach: primarily sandlance, starry flounder; 1 stomach: halibut, cod, pollock, and flounders; 1 stomach: a large cephalopod beak. (Wilke and Kenyon 1952)</p>
	<p>1958: WGOA, Summer, (n=94); 14 yearlings, 42 adult females, 18 terr. males, 20 nonterr. males. Prey (in order of FO): squid/octopus, bivalves, smelts, greenlings shrimp/crabs, rockfish, sculpins, isopods, unclassified crustaceans, segmented worms, and single occurrences of lamprey, salmon, sandlance, sand dollar, and coelenterate. (Mathisen et al. 1962)</p>
	<p>1959: WGOA, CGOA, EAI, Summer, (n=56); primarily adult males. Prey (in order of FO): squid/octopus, clam/mussel/snail, sandlance, rockfish, crab, greenling, sculpins, flatfish, and single occurrences of halibut and lumpfish. (Thorsteinson and Lensink 1962)</p>
	<p>1962: EBS, Winter-Spring, (n=unknown); Large numbers of sea lions in the southeastern Bering Sea, winter/spring of 1962. Suggests herring "staple food" of sea lions during this period. Suggests sea lion distribution was influenced by the distribution of herring. Tikhomirov (1964)</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
<p>1958-1963: CA and OR, Summer, (n=1); Animals were adult and mixed age females. Prey (in order of FO): salmon (100%), rockfish (100%). Winter, (n=5); Mixed age females. Prey (in order of FO): rockfish (80%); arrowtooth flounder (20%), sanddab (20%), herring (20%), flatfish (20%). Fiscus and Baines (1966)</p>	<p>1958-1963: GOA, AI, BS Summer,(n=16); Animals (mixed sexes and ages) taken in Alaskan waters fed mainly on small, schooling fishes. Near Unimak Pass in 1962, capelin was the major food species. A Steller sea lion taken in EGOA in May 1958 had eaten three salmon. Most of the food species (capelin, sandlance, sculpins, rockfishes and flatfishes) found in the stomachs of Steller sea lions suggest that they feed near land or in relatively shallow water (<100 fm, 180 m). Sea lions seen at distances of 70-85 miles from land by Fiscus and Kenyon in 1960 (Kenyon and Rice 1961). Fiscus and Baines (1966)</p>
<p>1968-1973: CA, (n=9); 9 stomachs with fish, and 7 with squid and octopus. Grouped 127 identified fishes according to schooling (open-water), bottom-dwelling (rocky), and inshore-schooling species; suggested sea lions feed mainly on bottom-dwelling fishes. Jones (1981)</p>	<p>1966 - 1969: Kuril Islands, Russia. (n = 71 w/food) Important prey by FO: pollock (n=45, 63.4%), greenlings (n=7, 9.9%), smooth lumpsucker (n=1, 1.4%), octopus (n=18, 25.4%), Gonatus squids (n=23, 32.4%), other squid (n=7, 9.9%), mollusk shells (n=4, 5.6%). Perlov (1975)</p>
<p>1973-1976: OR, Observations (84) of Steller sea lions (n=unknown # animals) feeding at surface, Rogue River, OR. Prey: 73 lampreys, 2 salmonids, 9 unidentified. Jameson and Kenyon (1977)</p>	<p>1974-1975: St. Paul, Summer, Observations (163) of Steller sea lions (n=unknown) taking 163 fur seal pups at St. George Island (Pribilof Is.) Estimated such predation may result in the mortality of about 3% to 7% of fur seal pups born at St. George Island. Gentry and Johnson (1981)</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
	<p>1975-1978: GOA, All seasons, (n=153). Stomach contents 95.7% fishes by volume, with 14 species of fish in 11 families. Gadids comprised 59.7% of total contents and occurred in 82.4% of stomachs with food. Walleye pollock comprised 58.3% of the total volume and occurred in 66.7% of stomachs with food. Cephalopods occurred in 36.6% of stomachs with contents but made up only 4.2% of total volume. Predation on salmon and capelin appeared to be largely limited to spring and summer. Prey (by combination rank index) included pollock, squids, herring, capelin, cod, salmon, octopus, sculpins, flatfishes, rockfishes. Herring and squids were extensively used in Prince William Sound but appeared to be relatively unimportant in other areas. Results for sea lions similar to results for harbor seals. Mean fork length (pollock otoliths, n=2030) was 29.8 cm (range 5.6 to 62.9 cm, SD = 11.6 cm). Pitcher (1981)</p>
	<p>1975-1978: GOA, All seasons, (n=153). NOTE: redundancy with previous results of Pitcher 1981. Fishes comprised 72.8%, cephalopods (octopus and Gonatid squids) 21.5%, decapod crustaceans (shrimps, tanner and spider crabs), 4.2% gastropods (marine snails) 0.8%, and mammals 0.4% of the prey occurrences. Fishes included minimum of 14 species of 11 families. Gadids composed nearly half of total occurrences and nearly 60% of total volume.</p> <p>Harbor seal remains were found in two stomachs (see Pitcher and Fay 1982). Seven top-ranked prey (in order of modified Index of Relative Importance) were pollock, herring, squids, capelin, salmon, Pacific cod, and sculpins. Pollock was dominant prey accounting for about 39% of all occurrences and 58% of the total volume. Pollock was top-ranked prey in all areas except Kodiak, where it was ranked second below capelin. Herring and squid were used extensively in Prince William Sound, but not in other areas. Predation on salmon and capelin was largely limited to spring and summer. Geographic differences in use of salmon and capelin may have been due to sampling at different - sites and seasons. Comparison with previous studies (Imler and Sarber 1947, Mathisen et al. 1962, Thorsteinson and Lensink 1962, and Fiscus and Baines 1966) which had more invertebrates, no herring, but included sandlance. Noted differences in sampling for this study (throughout year at wide range of locations) versus earlier studies (near rookeries during breeding season). Four of the five top-ranked prey were off-bottom schooling species. Calkins and Pitcher (1982)</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
	<p>1976: EBS, Pribilofs, March, (n=4). Prey (in order of FO): pollock, squids, and single occurrences of octopus, flatfish, lamprey, and prickleback. Based on otoliths, pollock consumed ranged from 34 cm to 57 cm in length. Also mentions the following prey items from a preliminary examination of 111 stomach samples collected in the central and western Bering Sea (in no particular order): pollock, cod, Gonatid squids, herring, octopus, and sculpins. Lowry et al. 1982</p>
	<p>1975-81: AI, March-October, (n=90; not stated how many had contents). Most pollock consumed (76%) were 20 cm or longer. Younger sea lions ([~]4 yr, all males) collected in 1981 ate significantly smaller fish (mean=26.9 cm, n=51). Animals collected in 1976 and 1979 (both near the Pribilofs) ate pollock averaging 46.9 cm in length (range 18.4-61.4 cm), while those collected in 1981 to the west ate substantially smaller pollock averaging 25.2 cm in length (range 8.3-64.2 cm). In 1981 sea lions collected in the central Bering Sea ate larger pollock than those off the Kamchatka Peninsula (mean=26.8 cm vs 23.5 cm)</p> <p>“It is unknown whether the consumption patterns described above are a result of actual size selection of prey or if they result from coincidental distribution of predators and prey size classes.”</p> <p>“.....the size range of pollock eaten by both young and old sea lions was similar.” Frost and Lowry 1986</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
<p>1985-1986: SEAK, Winter/Summer, (n=14). Fishes comprised 98% of volume, mostly Pacific cod (57%) and pollock (32%). Most frequently occurring were pollock (57%) and flatfishes (21%). Other prey observed were squid and octopus. Mean fork length (80 pollock otoliths from 8 sea lions) was 25.5 cm (range 4.8 to 55.7 cm, SD=10.4 cm). Calkins and Goodwin (1988)</p>	<p>1985-1986: CGOA, Winter/Summer, (n=74). Most important by volume were pollock (42%), octopus (26%), and flatfish (25%). Other prey: were fishes, squid, decapod crustaceans, and clams. Prey rank (based on combined rank index [Pitcher 1981]) in Kodiak area were pollock, octopus, flatfishes, sandlance, Pacific cod, and salmon. Mean fork length (1064 otoliths from 43 sea lions) in Kodiak area was 25.4 cm (range 7.9 to 54.2 cm, SD = 12.4 cm). Pollock was the most important prey item in both 1975-1978 collection (39% by FO in the Kodiak area) and 1985-1986 collection (58%). Capelin was most important in Kodiak area in 1975-1978. Suggest difference in capelin may be due to seasonal differences when animals were collected (spring-summer 1975-1978 vs. spring-autumn/early winter 1985-1986). Thus, comparisons may be compromised by potential seasonal bias. Octopus ranked second in 1985-1986 collection near Kodiak, but fifth in 1975-1978. Suggest difference may be due to collection site. Thus comparisons may be compromised by potential location bias. Sandlance occurred in 26% of sea lions from GOA in 1960s (Mathisen et al. 1962, Thorsteinson and Lensink 1962, Fiscus and Baines 1966), were not found in 1975-1978 sample, but were fourth in 1985-1986 sample. Calkins and Goodwin (1988)</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
<p>1992: CA, Summer, (n=1 observation). Observation of a territorial male Steller sea lion attack, kill, and consume what appeared to be a yearling California sea lion. Byrnes and Hood (1994)</p>	<p>1975-1978, 1985-1986: GOA, (note redundancy with Pitcher 1981, Calkins and Pitcher 1982, and Calkins and Goodwin 1988) Prey consumption based on FO. Most stomachs contained prey of only one kind. Pollock most common prey of juvenile (≤ 4 years old) and adult sea lions in virtually all seasons and areas during these two periods. Juvenile pollock were a major part of the diet in both periods. Juvenile sea lions ate smaller and relatively more juvenile pollock. Small forage fish were consumed on a seasonal basis. Temporal comparisons were possible only in the Kodiak region. The proportion of sea lions eating pollock increased from 49% in 1975-1978 to 69% in 1985-1986 in the Kodiak area. Small forage fish were the second most common prey in the 1970s, and flatfish were second in the 1980s. Of the fish consumed, 73% were ≤ 30 cm, but they accounted for only 26.8% of the biomass consumed. Half (50.7%) of the pollock mass consumed by juvenile sea lions came from fish ≤ 30 cm, while only 21% of the pollock mass consumed by adult sea lions came from juvenile pollock. Seasonal differences were observed in the consumption of all prey taxa, but differences were not found in the 1980s. Between the 1970s and the 1980s, the proportion consuming pollock and cephalopods increased significantly and the proportion consuming small forage fish and other demersal fish decreased. The increase in pollock consumed was only evident in summer months (all ages combined), but was evident in all seasons for juveniles. Note that sampling was not consistent with respect to seasons or specific locations between the two sampling periods, which weakens the basis for comparisons. Merrick and Calkins (1996)</p>

Table 4.2. Comparison of eastern and western stock Steller sea lion (*Eumetopias jubatus*) stomach collection study results from the 1950s through the 1990s.

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
	<p>1981: EBS, Spring, (n = 92). Males (ages 1-16 yrs) collected along the seasonal ice front in Bering sea. between March 24 and April 11, 1981. 37 collected in central Bering sea, “likely that most of the sea lions taken in this area originated at rookeries in the Aleutian Islands”. 73 collected in Russian far east waters near Olyutorskiy Gulf (no. of Kamchatka peninsula)</p> <p>Stomach contents calculated by full wt. - empty wt. = total wt. of contents. Less than 0.25 kg considered trace amounts. Prey identifications based primarily on fish otoliths, subopercle bones, and cephalopod mandibles. Importance of prey was compared by ranking, taking into account mass (wt.) and frequency of occurrence, using combined ranked index (CRI). Otolith measurements used to calculate fork lengths using regression analysis of otolith length and fish length (Frost & Lowry 1981). Pollock most important prey item in both study areas and occurred in 89% of stomachs with contents (322.1 kg; 67% by wt.) Pollock occurred in central Bering sea stomachs (100%); pollock in Russian Far east stomachs (83%). Mean size of pollock consumed in Bering sea stomachs was 25.2 cm (range = 6.2 - 64.2, SD= 7.9) based on measurement of 1299 otoliths.</p> <p>“Pollock consumed by sea lions in the Bering Sea were similar in size to those consumed in the Gulf of Alaska in the 1980s but were smaller than those consumed in the Gulf of Alaska in the 1970s.” Older (larger) sea lions (≥ 5 yrs.) ate larger pollock, mean = 25.8 cm. Younger sea lions (≤ 4 yrs.) consumed smaller pollock, mean = 22.1 cm. Pacific cod second most important prey item in both study areas occurring in 38% of all stomachs (28.1% in C. Bering Sea; 43.3% in Russian Far East) Other prey items: squid and octopus, herring, sculpins, phocid seals, flatfishes, cartilaginous fishes, crabs, and snails.</p>
	<p>“Sea lions were not found concentrated along the ice edge in any locations other than the two collection areas. It seems likely that they moved to and concentrated in these areas to take advantage of the pollock resources similar to the fishing fleets that were also present there at the time.” Most of the study area in the Central Bering Sea waters fell within the northern portion of the area known as the “doughnut”. Calkins (1998)</p>

EASTERN STOCK - 1950s through 1990s	WESTERN STOCK - 1950s through 1990s
	<p>1982 - 1984: CGOA, Shelikof Straits, Jan.-April, (n=36). Sea lion stomachs collected during Shelikof joint venture pollock fishery in Jan.-April. Both males (mean age 4.8 yrs.; 75% subadult or newly mature and probably not territorial) and females (age range 1-25 yrs, mean=6.43 yrs; 79% mature) were caught in during the trawl fishery. Prey from 1983 (n=19) stomachs: primarily pollock (range 34-49 cm, mean=39.3 cm, n=68). Sizes of pollock caught in the same net as sea lions ranged from 34-54 cm, mean=40 cm. Prey from 1984 (n=17) stomachs: primarily pollock (range 30-52 cm, mean=42.13 cm, n=93). Sizes of pollock caught in the same net as sea lions ranged from 31-54 cm (mean=43.5 cm, n=372). Loughlin and Nelson (1986)</p>
	<p>1985-1986: EBS, St. Paul, August, September and October, (n=11 stomachs, 2 colons). Collected samples from dead animals along shore of St. Paul Island. Age and sex groups : males 85%, females 15%. Otoliths (256) recovered from 7 stomachs (67%), octopus beaks from 3 (27%), crab from 2 (18%). Most common prey (from otoliths) was yellowfin sole (54% from 6 stomachs). Prey species (from otoliths): Yellowfin sole (149 of 256 otoliths or 58%), Pacific cod (5 stomachs, 41 of 256 otoliths or 16%), pollock (2.7%) and halibut (1 otolith recovered). Octopus beaks (4 individuals) were recovered in 3 stomachs. Gearin (unpublished)</p>
	<p>1994 - 1996: Hokkaido, Japan, Jan.-March, (n=62) Stomachs collected off coast of Rausu, Hokkaido, Japan. Sex of sea lions collected: 12 males, 24 females, but no ages given.. Prey identifications based on fish bones, otoliths and beaks. Important prey by FO: pollock (n=55, 88.7%), Pacific cod (n=47, 75.8%), Saffron cod (n=25, 40.3%), flatfish (n=15, 24.2%), other fish (n=24, 38.7%), squids (n=43, 69.4%), octopus (n=7, 11.3%). Prey size consumed: pollock 40 -50 cm (30.36 ± 3.04 (SD) in 1994 and 42.33 ± 2.84 (SD) cm in 1995). Noted that “this is almost the same size as that caught by the commercial fishery”. When sea lions were grouped by sex and age (<4 yrs and ≥4 yrs old) there was no significant difference in the size of pollock consumed between the two age groups or between sexes. Goto and Shimazaki (1997)</p>

Table 4.3. Locations of instrumented Steller sea lions inside and outside of critical habitat based on satellite data.

	Number of Locations	Number of Locations	Percentage	Number of Locations	# of Animals	Locations
Breeding	Within Critical Habitat	Outside Critical Habitat		Total	(n)	Per animal
Jan-Mar	260.00	5.00	1.89	265.00	5.00	53.00
Apr-June	101.00	22.00	17.89	123.00	4.00	30.75
July-Sept	401.00	0.00	0.00	401.00	13.00	30.85
Oct-Dec	4.00	5.00	55.56	9.00	2.00	4.50
Non-Breeding						
Jan-Mar	1210.00	10.00	0.82	1220.00	20.00	61.00
Apr-June	1110.00	66.00	5.61	1176.00	13.00	90.46
July-Sept	71.00	0.00	0.00	71.00	2.00	35.50
Oct-Dec	264.00	24.00	8.33	288.00	9.00	32.00

Table 4.4. Percent frequency of occurrence of all taxa identified in stomach samples collected from 1956 to 1986 throughout the range of Steller sea lions. Values are shown for the entire range in all years and for the Eastern and Western stocks during two time periods; from the 1950-70's and the 1980's.

Species	% Frequency of Occurrence					
	All Years RANGE n=781	1950's - 1970's		1980's		
		EASTERN n=196	WESTERN n=394	EASTERN n=14	WESTERN n=177	
Pollock	39.2	9.2	38.6	57.1	72.3	
Octopus sp.	16.5	23.0	9.9	7.1	24.9	
Pacific Cod	8.6	1.0	4.8	7.1	25.4	
Cephalopods	7.8	0.0	15.5	0.0	0.0	
Clamshell	7.4	3.6	11.9	0.0	2.3	
Rockfish unident.	6.7	16.3	4.8	0.0	0.6	
Pacific herring	6.5	9.7	4.1	14.3	7.9	
Gonatid squid	4.5	0.0	8.9	0.0	0.0	
Sandlance	3.5	1.5	4.8	0.0	2.8	
Squid	3.5	5.6	0.8	14.3	6.2	
Fish unident.	3.2	0.0	4.8	14.3	2.3	
Capelin	3.2	0.0	6.3	0.0	0.0	
Righteye flounder unident.	3.1	0.0	2.8	21.4	5.6	
Sculpin unident.	2.8	0.0	3.0	0.0	5.6	
Greenling unident.	2.7	0.0	5.3	0.0	0.0	
Salmon	2.7	5.6	1.8	7.1	1.1	
Gonatus magister	2.6	0.0	5.1	0.0	0.0	
Flatfishes	1.9	3.6	0.3	0.0	4.0	
Milk	1.8	6.6	0.3	0.0	0.0	
Dogfish	1.7	6.6	0.0	0.0	0.0	
Smelt unident.	1.7	0.0	3.3	0.0	0.0	
Shrimps	1.7	1.5	2.0	0.0	1.1	
Pacific Hake	1.4	5.6	0.0	0.0	0.0	
Crustaceans	1.4	0.0	2.8	0.0	0.0	
Stones and gravel	1.3	0.0	2.5	0.0	0.0	
Sculpin unident.	1.2	0.0	1.5	0.0	1.7	
Crab unident.	1.0	0.0	1.3	0.0	1.7	
Yellowfin sole	0.9	0.5	0.0	0.0	3.4	
Ommatostrephidae	0.8	0.0	1.5	0.0	0.0	
Ratfish	0.6	2.6	0.0	0.0	0.0	
Tanner Crab	0.6	0.0	0.5	0.0	1.7	
Telost fish unident.	0.5	0.0	0.0	0.0	2.3	
Cartilaginous fish unident.	0.5	0.0	0.0	0.0	2.3	
Pacific halibut	0.5	0.5	0.3	0.0	1.1	
Gadidae	0.5	0.0	0.5	0.0	1.1	
Shell fragments	0.4	0.0	0.0	0.0	1.7	
Lamprey	0.4	0.5	0.5	0.0	0.0	
Isopods	0.4	0.0	0.8	0.0	0.0	
Buccinum sp.	0.4	0.0	0.0	0.0	1.7	
Spotted seal	0.3	0.0	0.3	0.0	0.6	
Skate unident.	0.3	0.5	0.3	0.0	0.0	

Table 4.5a. Percent frequency of occurrence of prey items recovered from Steller sea lion scat collected in winter (December-April, 1990-1998; NMFS unpublished data).

Region Sample size Species	RANGE n=1685	CGOA n=358	% Frequency of Occurrence				CAI n=122	WAI no data
			WGOA n=491	EAI n=714	CAI n=122	WAI no data		
POLLOCK	62.4	52.8	83.9	62.7	1.6			
PACIFIC COD	27.2	28.8	37.1	21.4	17.2			
ATKA MACKEREL	16.5	5.0	4.3	21.7	68.9			
SALMON	13.4	10.6	9.8	17.5	11.5			
IRISH LORD SP	11.7	13.1	9.2	12.6	12.3			
SNAILFISH SP	9.0	10.6	4.7	10.4	13.9			
ARROWTOOTH FL	8.8	20.4	9.4	3.5	3.3			
SAND FISH	8.3	5.6	1.8	15.4	0.8			
SAND LANCE	7.1	16.8	8.6	2.4	0.0			
UNID. FLATFISH	6.8	7.0	6.1	8.0	1.6			
HERRING	5.9	21.2	3.9	0.6	0.0			
ROCK SOLE	5.8	11.2	5.9	3.5	2.5			
UNID GADID	5.6	11.5	4.1	4.5	1.6			
CEPHALOPODS	5.1	7.5	2.6	4.2	13.1			
ROCKFISH SP	4.3	3.6	3.9	5.3	2.5			
POLYCHAETE UNID	2.7	2.0	2.6	2.2	8.2			
GREENLING SPP	2.5	0.6	2.0	3.5	4.1			
SM. LUMPSUCKER	2.4	0.0	0.6	4.8	3.3			
ROCK GREENLING	2.4	0.0	0.0	1.1	26.2			
SCULPIN	2.1	3.1	0.6	2.8	0.8			
HALIBUT	1.6	0.8	0.6	2.8	0.8			
GUINNELS	1.3	1.7	1.2	1.1	1.6			
KELP GREENLING	1.3	0.0	0.0	3.1	0.0			
STARRY FLOUNDER	0.8	2.0	0.2	0.8	0.0			
POACHER SP	0.8	0.8	1.2	0.6	0.0			
RED IRISH LORD	0.8	0.3	1.0	0.7	1.6			
SKATE	0.7	1.7	0.0	0.6	1.6			
SMELT SPP	0.7	0.8	0.8	0.7	0.0			
BIRD or MAMMAL	0.5	0.0	0.0	1.3	0.0			
MYCTOPHID SP	0.5	0.6	0.2	0.3	2.5			
CAPELIN	0.4	1.1	0.0	0.3	0.0			
GYMNOCANTHUS SP	0.4	0.8	0.4	0.1	0.0			
RONQUIL SP	0.4	0.0	0.4	0.6	0.0			
STICHAEIDAE SP	0.4	0.6	0.4	0.3	0.0			
EULACHON	0.3	0.6	0.4	0.1	0.0			
CARTLAG. FISH	0.2	0.3	0.0	0.3	0.0			
SMOOTH TONGUE	0.2	0.0	0.4	0.1	0.0			
TUBESNOUT	0.2	0.6	0.2	0.0	0.0			
STICKELBACK SP	0.1	0.3	0.0	0.1	0.0			
<i>scats containing unid. prey</i>	<i>134</i>	<i>40</i>	<i>33</i>	<i>50</i>	<i>11</i>			

Table 4.5b. Percent frequency of occurrence of prey items recovered from Steller sea lion scat collected in summer (May-September, 1990-1998; NMFS unpublished data).

Region	RANGE	CGOA	WGOA	EAI	CAI	WAI
Sample size	n=2168	n=245	n=282	n=408	n=884	n=349
Species	% Frequency of Occurrence					
ATKA MACKEREL	58.9	0.0	1.8	30.6	92.3	95.1
POLLOCK	32.5	64.5	80.1	50.5	11.9	2.9
SALMON	25.5	40.4	45.7	34.1	18.8	5.4
CEPHALOPODS	12.4	4.1	0.7	6.4	21.8	10.6
HERRING	7.5	6.9	3.2	33.1	0.1	0.0
PACIFIC COD	7.1	4.9	9.9	7.4	6.6	7.2
ARROWTOOTH FL	6.2	35.1	11.0	2.9	0.6	0.0
SAND LANCE	5.5	9.4	18.4	8.1	0.9	1.1
IRISH LORD SP	4.6	0.4	5.7	6.4	2.9	8.6
UNID GADID	3.6	5.7	6.7	4.4	2.3	2.0
ROCK SOLE	2.3	0.8	1.4	9.6	0.6	0.0
POLYCAETE UNID	2.2	1.2	2.5	2.0	2.8	1.4
ROCKFISH SP	2.0	1.2	3.5	1.5	2.4	1.1
SKATE	1.5	1.2	0.4	3.7	1.5	0.3
SMOOTH TONGUE	1.5	0.0	0.0	3.4	2.0	0.0
FLATFISH SP	1.3	2.0	1.4	2.7	0.7	0.9
SAND FISH	1.2	1.2	0.7	4.7	0.2	0.0
SMELT SPP	1.1	7.3	1.1	0.5	0.0	0.0
CAPELIN	0.8	2.9	0.7	2.2	0.0	0.0
GREENLING SPP	0.8	0.0	1.4	1.5	0.5	0.9
HALIBUT	0.8	1.6	0.7	2.5	0.1	0.0
STURGEON POACHER	0.8	0.0	0.0	4.2	0.0	0.0
ROCK GREENLING	0.7	0.0	0.0	2.7	0.5	0.3
BIRD or MAMMAL	0.6	0.0	0.7	0.2	0.6	1.4
SM. LUMPSUCKER	0.6	0.0	0.0	0.0	1.4	0.0
SCULPIN	0.5	0.0	0.4	1.5	0.3	0.3
MYCTOPHID SP	0.5	0.4	0.0	0.0	1.0	0.0
HAKE	0.4	1.2	1.1	0.2	0.2	0.0
LAMPREY SPP	0.4	0.0	0.7	1.0	0.3	0.0
POACHER SP	0.4	0.0	0.0	2.0	0.1	0.0
SABLEFISH	0.4	2.4	0.4	0.5	0.0	0.0
SNAILFISH SP	0.4	0.4	0.4	0.0	0.7	0.3
YELLOWFIN SOLE	0.3	0.0	0.0	1.5	0.0	0.0
STARRY FLOUNDER	0.2	0.0	0.4	1.0	0.0	0.0
YELLOW IRISH LORD	0.2	0.0	0.4	0.2	0.0	0.9
GUNNELS	0.2	0.0	0.7	0.5	0.0	0.0
KELP GREENLING	0.2	0.0	0.0	0.5	0.1	0.3
PENPOINT GUNNEL	0.2	0.0	0.0	1.0	0.0	0.0
RED IRISH LORD	0.2	0.0	0.4	0.0	0.1	0.6
EULACHON	0.1	0.8	0.4	0.0	0.0	0.0
<i>scats containing und prey</i>	127	22	20	38	28	19

Table 4.6. Counts of adult and juvenile (non-pup) Steller sea lions at rookery and haulout trend sites by region (NMFS unpubl., Sease 2000). For the GOA, the eastern sector includes rookeries from Seal Rocks in Prince William Sound to Outer Island; the central sector extends from Sugarloaf and Marmot Islands to Chowiet Island; and the western sector extends from Atkins Island to Clubbing Rocks. For the Aleutian Islands, the eastern sector includes rookeries from Sea Lion Rock (near Amak Island) to Adugak Island; the central sector extends from Yunaska Island to Kiska Island; and the western sector extends from Buldir Island to Attu Island.

Year	Gulf of Alaska			Aleutian Islands			Southeast Alaska
	Eastern	Central	Western	Eastern	Central	Western	
1975				19,769			
1976	7,053	24,678	8,311	19,743			
1977				19,195			
1979					36,632	14,011	6,376
1982							6,898
1985		19,002	6,275	7,505	23,042		
1989	7,241	8,552	3,800	3,032	7,572		8,471
1990	5,444	7,050	3,915	3,801	7,988	2,327	7,629
1991	4,596	6,273	3,734	4,231	7,499	3,085	7,715
1992	3,738	5,721	3,720	4,839	6,399	2,869	7,558
1994	3,369	4,520	3,982	4,421	5,790	2,037	8,826
1996	2,133	3,915	3,741	4,716	5,528	2,190	8,231
1997		3,352	3,633				
1998		3,346	3,361	3,847	5,761	1,913	8,693
1999	1,952						
2000	1,894	3,117	2,842	3,842	5,427	1,071	

Table 5.1. Groundfish and Squid Catches (metric tons) in the Eastern Bering Sea, 1964–1985 (NMFS 1999).

Year	Catches of Pollock (in metric tons) and Percentages						Total Groundfish Catch (in metric tons)					
	Bering Sea	%	Aleutian Islands	%	Gulf of Alaska	%	Total	Bering Sea	Aleutian Islands	Gulf of Alaska	Total	%
1964	174,792	0.4438			1,126	0.0045	175,918	393,891		248,192	642,083	0.2740
1965	230,551	0.6695			2,749	0.0076	233,300	344,369		360,131	704,500	0.3312
1966	261,678	0.5788			8,932	0.0404	270,610	452,081		221,172	673,253	0.4019
1967	550,362	0.6581			6,276	0.0451	556,638	836,308		139,206	975,514	0.5706
1968	702,181	0.7261			6,164	0.0490	708,345	967,083		125,822	1,092,905	0.6481
1969	862,789	0.7238			17,553	0.1549	880,342	1,192,020		113,333	1,305,353	0.6744
1970	1,256,565	0.7885			9,343	0.1099	1,265,908	1,593,649		84,983	1,678,632	0.7541
1971	1,743,763	0.8159			9,458	0.0817	1,753,221	2,137,326		115,758	2,253,084	0.7781
1972	1,874,534	0.8722			34,081	0.2147	1,908,615	2,149,092		158,768	2,307,860	0.8270
1973	1,758,919	0.8520			36,836	0.2550	1,795,755	2,064,444		144,478	2,208,922	0.8130
1974	1,588,390	0.8360			61,880	0.4041	1,650,270	1,900,092		153,143	2,053,235	0.8037
1975	1,356,736	0.8246			59,512	0.4191	1,416,248	1,645,232		142,015	1,787,247	0.7924
1976	1,177,822	0.8245			86,527	0.4971	1,264,349	1,428,565		174,081	1,602,646	0.7889
1977	978,370	0.8375	7,625	0.1132	112,089	0.5726	1,098,084	1,168,144	67,348	195,768	1,431,260	0.7672
1978	979,431	0.7520	6,282	0.1028	90,822	0.5647	1,076,535	1,302,509	61,092	160,830	1,524,431	0.7062
1979	913,881	0.7881	9,504	0.1264	98,508	0.6056	1,021,893	1,159,547	75,195	162,675	1,397,417	0.7313
1980	958,279	0.7842	58,156	0.5358	110,100	0.5439	1,126,535	1,221,944	108,531	202,426	1,532,901	0.7349
1981	973,505	0.7728	55,516	0.5328	139,168	0.5811	1,168,189	1,259,666	104,199	239,476	1,603,341	0.7286
1982	955,964	0.7891	57,978	0.5902	168,693	0.7209	1,182,635	1,211,483	98,233	234,001	1,543,717	0.7661
1983	982,363	0.7673	59,026	0.6238	215,567	0.7258	1,256,956	1,280,285	94,617	296,988	1,671,890	0.7518
1984	1,098,783	0.7535	81,834	0.5566	307,400	0.8619	1,488,017	1,458,299	147,022	356,659	1,961,980	0.7584
1985	1,179,759	0.7154	58,730	0.5183	284,823	0.8883	1,523,312	1,649,109	113,310	320,656	2,083,075	0.7313

Notes:

a = Arrowtooth flounder included in Greenland turbot catch statistics.

b = Includes POP shortraker, rougheye, northern and sharpchin.

c = Rockssole prior to 1991 is included in other flatfish catch statistics.

d = Through December 31, 1998.

e = Through Dec 31,1999 compiled from NMFS Region website.

Numbers don't include fish taken for research.

Table 5.2. Major fish prey from stomachs of Steller sea lions collected in Southeast Alaska, Kodiak Island, and the Gulf of Alaska during 1975-1993. Ranks are determined from the frequency of occurrence of prey in stomachs with contents (shown as percentage). The rank of stomach contents from Kodiak Island during 1990-1993 was determined from the percent frequency of occurrence of prey in scats with contents. The sizes of the various samples are shown below the location and sampling period.

Rank	Gulf of Alaska 1975-1978 n = 178	Kodiak 1975 - 1978 n = 63	Kodiak 1985-1986 n = 67	Kodiak 1990-1993 n = 54	SE Alaska 1986 n = 14
1	walleye pollock 69.1%	walleye pollock 49.2%	walleye pollock 68.7%	walleye pollock 64.8%	walleye pollock 64.3%
2	capelin 13.4%	capelin 28.1%	flatfish 13.4%	salmon 24.1%	flatfish 28.6%
3	Pacific cod 12.8%	Pacific cod 14.1%	Pacific cod 10.3%	Atka mackerel 16.7%	Pacific herring 14.3%
4	Pacific herring 8.9%	flatfish and salmon 7.9%	sand lance 7.4%	flatfish 14.8%	-
5	flatfish 5.1%	-	-	sand lance 7.4%	-

Table 5.3 Summary of estimates of Steller sea lion (SSL) mortality caused by killer whale (KW) predation. In alternatives 1-4, it was assumed that the SSL population was fixed at 42,000 animals and the crude death rate was 20% excluding killer whale predation. In alternative 5, the SSL population was fixed at 100,000. All models used an underlying decline of 5% per year for SSLs in estimating the percent mortality due to killer whale predation.

<i>Input parameters for model</i>	<i>Alternative Models</i>				
	1	2	3	4	5
Amount Consumed by KW (kg/day)	74	74	74	74	74
Number of Days Feeding	365	365	365	365	365
Number of Killer Whales	125	125	125	125	125
Weight Per SSL (kg)	160	160	160	160	160
Percent of SSL in KW Diet	12.5%	10%	15%	5%	12.5%
<i>Estimates regarding predation by killer whales</i>					
Number of SSLs Eaten Per Year	2638	2110	6330	5275	5275
Mortality Rate = (# SSL eaten)/(total # of SSL)	6%	5%	8%	2.5%	3%
Total Mortality Rate Due to Killer Whales	24%	20%	27%	11%	12%

Table 5.4 Census information for selected communities in the Bering Sea, Aleutian Islands, and Gulf of Alaska.

Area	1980s	1990s	1999
Alaska	401,851	550,043	619,500
Aleutians East Borough	1,643	2,464	2,179
Aleutians West Borough	6,125	9,478	3,913
Anchorage Borough	174,431	226,338	257,808
Bethel Census Area	10,999	13,656	16,215
Bristol Bay Borough	1,094	1,410	1,061
Dillingham Census Area	3,232	4,012	4,565
Kenai Peninsula Borough	25,282	40,802	48,993
Kodiak Island Borough	9,939	13,309	14,350
Lake and Peninsula Borough	1,384	1,668	1,748
Valdez - Cordova Census Area	8,348	9,952	10,229

Table 5.5. Number of fin whales killed in the North Pacific prior to the whaling ban (from Tilman 1977)

Year	No. Whales Taken	Year	No. Whales Taken	Year	No. Whales Taken
1963	2503	1967	2272	1971	802
1964	3991	1968	1942	1972	758
1965	3165	1969	1276	1973	455
1966	2885	1970	1012	1974	413

Table 5.6. Number of sei whales killed in the North Pacific prior to the whaling ban (from Tilman 1977)

Year	No. Whales Taken	Year	No. Whales Taken	Year	No. Whales Taken
1963	2590	1967	6053	1971	2993
1964	3642	1968	5740	1972	2327
1965	3172	1969	5157	1973	1856
1966	4406	1970	4503	1974	1280

Table 5.7 Estimate of Steller Sea Lion baseline mortality due to take for 1959-1999 in the action area¹

Description of Take	Dates	Rate of Take	Total Estimated Take
Entanglement in Marine Debris	(1970-1990) 1985	100 per year 0.07%	2,000 no estimate
Commercial Harvests	(1959) (1963-1972)		630 males 45,178 pups
Subsistence Harvests	1959-1991 (1992-1995) (1996-1999)	no estimate 448/ year (est) 178/year (est)	2,000 600
Incidental Catch	1959-1966 1966-1977 1978-1988 1989-1999	no estimate 1,000-2,000/yr 100-2,000/yr <50/yr	no estimate 14,000-16,000 5,700-7,400 no estimate
Research	1975/78 1985/86 1989	62/yr 89/yr 16	250 178 16
Intentional Fisheries Take	(1956-1990)		52,000
Total Estimated Take	1970-1999		123,000 – 126,000

¹ Based on the following reviews: Entanglement (Calkins 1985; Loughlin et al. 1986), Commercial Harvest (Merrick et al. 1987), Subsistence Harvest (Wolfe and Mishler [all 4 pubs]), Incidental catch (Perez and Loughlin 1991), Research (Calkins and Goodwin 1988; Calkins et al. 1994), and Intentional take (Trites and Larkin 1992)

Table 5.8 Groundfish and Squid Catches in the eastern Bering Sea from 1954 to 1999 (in metric tons).

Year	Pollock	Pacific Cod	Sable Fish	Pacific Ocean Perch Complex	Other Rock Fish	Yellow Fin Sole	Greenland Turbot	Arrow-Tooth Flounder	Other Flatfish	Rock Sole	Atka Mackerel	Squid	Other Species	Total
1954						12,562								12,562
1955						14,690								14,690
1956						24,697								24,697
1957						24,145								24,145
1958	6,924	171	6			44,153							147	51,401
1959	32,793	2,864	289			185,321							380	221,647
1960			1,861	6,100		456,103	36,843	a						500,907
1961			15,627	47,000		553,742	57,348	a						673,717
1962			25,989	19,900		420,703	58,226	a						524,818
1963			13,706	24,500		85,810	31,565	a	35,643					191,224
1964	174,792	13,408	3,545	25,900		111,177	33,729	a	30,604				736	393,891
1965	230,551	14,719	4,838	16,800		53,810	9,747	a	11,686				2,218	344,369
1966	261,678	18,200	9,505	20,200		102,353	13,042	a	24,864				2,239	452,081
1967	550,362	32,064	11,698	19,600		162,228	23,869	a	32,109				4,378	836,308
1968	702,181	57,902	4,374	31,500		84,189	35,232	a	29,647				22,058	967,083
1969	862,789	50,351	16,009	14,500		167,134	36,029	a	34,749				10,459	1,192,020
1970	1,256,565	70,094	11,737	9,900		133,079	19,691	12,598	64,690				15,295	1,593,649
1971	1,743,763	43,054	15,106	9,800		160,399	40,464	18,792	92,452				13,496	2,137,326
1972	1,874,534	42,905	12,758	5,700		47,856	64,510	13,123	76,813				10,893	2,149,092
1973	1,758,919	53,386	5,957	3,700		78,240	55,280	9,217	43,919				55,826	2,064,444
1974	1,588,390	62,462	4,258	14,000		42,235	69,654	21,473	37,357				60,263	1,900,092
1975	1,356,736	51,551	2,766	8,600		64,690	64,819	20,832	20,393				54,845	1,645,232
1976	1,177,822	50,481	2,923	14,900		56,221	60,523	17,806	21,746				26,143	1,428,565
1977	978,370	33,335	2,718	2,654	311	58,373	27,708	9,454	14,393			4,926	35,902	1,168,144
1978	979,431	42,543	1,192	2,221	2,614	138,433	37,423	8,358	21,040		831	6,886	61,537	1,302,509
1979	913,881	33,761	1,376	1,723	2,108	99,017	34,998	7,921	19,724		1,985	4,286	38,767	1,159,547
1980	958,279	45,861	2,206	1,097	459	87,391	48,856	13,761	20,406		4,955	4,040	34,633	1,221,944
1981	973,505	51,996	2,604	1,222	356	97,301	52,921	13,473	23,428		3,027	4,182	35,651	1,259,666

Table 5.8 Groundfish and Squid Catches in the eastern Bering Sea from 1954 to 1999 (in metric tons).

Year	Pollock	Pacific Cod	Sable Fish	Pacific Ocean Perch Complex	Other Rock Fish	Yellow Fin Sole	Greenland Turbot	Arrow-Tooth Flounder	Other Flatfish	Rock Sole	Atka Mackerel	Squid	Other Species	Total
1982	955,964	55,040	3,184	224	276	95,712	45,805	9,103	23,809		328	3,838	18,200	1,211,483
1983	982,363	83,212	2,695	221	220	108,385	43,443	10,216	30,454		141	3,470	15,465	1,280,285
1984	1,098,783	110,944	2,329	1,569	176	159,526	21,317	7,980	44,286		57	2,824	8,508	1,458,299
1985	1,179,759	132,736	2,348	784	92	227,107	14,698	7,288	71,179		4	1,611	11,503	1,649,109
1986	1,188,449	130,555	3,518	560	102	208,597	7,710	6,761	76,328		12	848	10,471	1,633,911
1987	1,237,597	144,539	4,178	930	474	181,429	6,533	4,380	50,372		12	108	8,569	1,639,121
1988	1,228,000	192,726	3,193	1,047	341	223,156	6,064	5,477	137,418		428	414	12,206	1,810,470
1989	1,230,000	164,800	1,252	2,017	192	153,165	4,061	3,024	63,452		3,126	300	4,993	1,630,382
1990	1,353,000	162,927	2,329	5,639	384	80,584	7,267	2,773	22,568		480	460	5,698	1,644,109
1991	1,268,360	165,444	1,128	4,744	396	94,755	3,704	12,748	30,401	46,681	2,265	544	16,285	1,647,455
1992	1,384,376	163,240	558	3,309	675	146,942	1,875	11,080	34,757	51,720	2,610	819	29,993	1,831,954
1993	1,301,574	133,156	669	3,763	190	105,809	6,330	7,950	28,812	63,942	201	597	21,413	1,674,406
1994	1,362,694	174,151	699	1,907	261	144,544	7,211	13,043	29,720	60,276	190	502	23,430	1,818,628
1995	1,264,578	228,496	929	1,210	629	124,746	5,855	8,282	34,861	54,672	340	364	20,928	1,745,890
1996	1,189,296	209,201	629	2,635	364	129,509	4,699	13,280	35,390	46,775	780	1,080	19,717	1,653,355
1997	1,115,268	209,475	547	1,060	161	166,681	6,589	8,580	42,374	67,249	171	1,438	20,997	1,640,590
1998/d	1,101,428	160,681	586	1,134	203	101,310	8,303	14,985	39,940	33,221	901	891	23,156	1,486,739
1999/e	998,703	147,281	677	653	141	69,265	5,206	10,628	34,389	40,505	1,165	392	18,973	1,327,978

Notes: a = Arrowtooth flounder included in Greenland turbot catch statistics.
b = Includes POP shortraker, rougheye, northern and sharpchin.
c = Rocksole prior to 1991 is included in other flatfish catch statistics.
d = Through December 31, 1998.
e = Through Dec 31,1999 compiled from NMFS Region website.
Numbers don't include fish taken for research.

Table 5.9a Groundfish catch in the BSAI groundfish fisheries and associated bycatch of chinook salmon and “other” salmon (Source: NMFS, Alaska Region, Juneau, AK).

Year	Gear Type	Groundfish (metric tons)	Chinook (#s)	Other Salmon (#s)
1999*	Trawl	1,113,572	13,533	49,752
	Hook-and-line	91,141	3	31
	Pot Gear	15,788	9	0
	Jig	137	0	0
	Total	1,220,637	13,545	49,783
1998	Trawl	1,476,210	58,967	69,242
	Hook-and-line	130,359	4	62
	Pot Gear	14,155	0	0
	Jig	196	0	0
	Total	1,620,920	58,971	69,305
1997	Trawl	1,653,841	50,519	66,916
	Hook-and-line	153,853	11	79
	Pot Gear	22,658	0	0
	Jig	201	0	0
	Total	1,830,553	50,530	66,994
1996	Trawl	1,698,562	63,179	77,991
	Hook-and-line	116,169	26	69
	Pot Gear	33,639	0	0
	Jig	273	0	0
	Total	1,848,643	63,205	78,060
1995	Trawl	1,781,965	22,691	21,817
	Hook-and-line	126,069	745	57
	Pot Gear	21,101	0	1
	Jig	616	0	0
	Total	1,929,751	23,436	21,875

* Amounts calculated on October 1999.

Table 5.9b Groundfish catch in the GOA groundfish fisheries and associated bycatch of chinook salmon and other salmon (Source: NMFS, Alaska Region, Juneau, AK)

Year	Gear Type	Groundfish (metric tons)	Chinook (#s)	Other Salmon (#s)
1999*	Trawl	155,541	18,214	7,031
	Hook-and-line	25,686	0	0
	Pot Gear	18,125	0	0
	Jig	75	0	0
	Total	199,427	18,214	7,031
1998	Trawl	208,761	16,941	13,539
	Hook-and-line	25,467	0	0
	Pot Gear	10,806	0	0
	Jig	79	0	0
	Total	245,114	16,941	13,539
1997	Trawl	195,261	15,230	3,014
	Hook-and-line	25,937	0	0
	Pot Gear	9,417	0	0
	Jig	340	0	0
	Total	230,955	15,230	3,014
1996	Trawl	161,895	15,761	4,176
	Hook-and-line	27,261	0	0
	Pot Gear	12,296	0	0
	Jig	604	0	0
	Total	202,055	15,761	4,176
1995	Trawl	167,172	14,646	64,510
	Hook-and-line	31,863	6	179
	Pot Gear	16,251	0	0
	Jig	600	0	0
	Total	215,886	14,652	64,688

* Amounts calculated on October 1999.

Table 5.10. Breakdown of “other” salmon bycatch in BSAI and GOA groundfish fisheries (Source: NMFS, Alaska Fisheries Science Center; from the Observer Database)

		Percent of “Other” Salmon Category					
Area	Year	Gear Type	Chum Salmon	Coho	Sockeye	Pink	Steelhead
BSAI	1999	Trawl	96.891	2.912	0.004	0.193	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
	1998	Trawl	99.704	0.220	0.016	0.060	0.000
		Hook-and-line	81.061	18.939	0.000	0.000	0.000
	1997	Trawl	99.738	0.160	0.098	0.004	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
	1996	Trawl	99.707	0.289	0.002	0.002	0.000
		Hook-and-line	79.289	13.971	0.000	6.740	0.000
	1995	Trawl	95.917	3.985	0.000	0.098	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
GOA	Average	Trawl	98.391	1.513	0.024	0.071	0.000
		Hook-and-line	92.070	6.582	0.000	1.348	0.000
	1999	Trawl	75.923	20.526	1.761	1.790	0.000
		Hook-and-line	15.686	84.314	0.000	0.000	0.000
	1998	Trawl	71.723	22.035	1.490	4.752	0.000
		Hook-and-line	12.800	53.600	25.600	8.000	0.000
	1997	Trawl	98.095	0.939	0.234	0.732	0.000
		Hook-and-line	60.561	39.439	0.000	0.000	0.000
	1996	Trawl	95.902	3.947	0.060	0.091	0.000
		Hook-and-line	38.327	50.348	0.000	11.325	0.000
Average	1995	Trawl	99.060	0.862	0.064	0.014	0.000
		Hook-and-line	20.109	75.043	0.000	4.848	0.000
	Average	Trawl	88.141	9.662	0.722	1.476	0.000
	Hook-and-line	29.497	60.549	5.120	4.835	0.000	

Table 5.11. Alaska OCS oil and gas lease sales.

Planning Area	Sale Number	Sale Date	No. leases issued	Disposition
Aleutian Basin [North]	Sale 92	Oct 1988	23	all leases have been relinquished
Cook Inlet	Sale 60	Sep 1981	13	all leases have expired
Cook Inlet	Sale CI	Oct 1987	87	all leases have expired
Cook Inlet	Sale 149	Oct 1997	87	sale area has two active leases
Gulf of Alaska	Sale 39	Apr 1976	76	all leases have expired
Gulf of Alaska	Sale 55	Oct 1980	35	all leases have expired
Navarin Basin	Sale 83	Apr 1984	163	all leases have been relinquished
Norton Basin	Sale 57	Mar 1983	59	all leases have been relinquished
St. George Basin	Sale 70	Apr 1983	96	all leases have been relinquished

Table 6.1. Analysis of recruitment of various groundfish species in the EBS, AI, and GOA. The Dickey-Fuller test takes as the null hypothesis that the variable is nonstationary. A statistically significant number for that test means that the null hypothesis is rejected and the series is stationary. The KPSS test (Kwiatowski et al. 1992) takes as the null hypothesis that the variable is stationary. A significant positive number indicates that the null hypothesis is rejected and the series is nonstationary. The last column indicates if there are autoregressive terms, order 0 means no significant autoregressive terms, order 1 means a first order autoregressive process. Where results of the stationary tests are contradictory, the residuals were also tested after running the model.

Management unit	Dickey-Fuller	KPSS	Autoregressive order
EBS pollock	?	?	0
EBS Pacific cod	N	N	0
EBS yellowfin sole <i>residuals</i>	N S	S S	1
EBS Greenland turbot <i>residuals</i>	S S	N S	1 0
EBS arrowtooth flounder	N	S	0
EBS rock sole <i>residuals</i>	N S	S S	1
EBS flathead sole	N	?	1
EBS Alaska plaice	N	N	1
Sablefish	N	S	0
AI POP	N	N	0
EBS POP	S	S	1
AI Atka mackerel	N	S	0
GOA pollock <i>residuals</i>	S S	N S	1
GOA Pacific cod	N	N	0
GOA arrowtooth flounder <i>residuals</i>	N N	S S	1
GOA POP	N	S	0
GOA thornyhead rockfish <i>residuals</i>	N S	N S	1

Table 6.2. Summary of the possible effects of harvesting groundfish in the BSAI and GOA with various gear types.

	Trawl	Hook-and-line	Pot	Jig
Percentage of total catch in 1999	BSAI = 86% GOA = 73%	BSAI = 12% GOA = 14%	BSAI = 2% GOA = 13%	BSAI = 0.02% GOA = 0.1%
Maximum rate of removal (mt/week in 1999)	BSAI = 96,072 GOA = 18,357	BSAI = 10,155 GOA = 4,336	BSAI = 5,753 GOA = 4,087	BSAI = 47 GOA = 34
Number of vessels in 1998	BSAI = 166 GOA = 198	BSAI = 115 GOA = 876	BSAI = 79 GOA = 178	
Bycatch of prohibited species	salmon herring halibut crab	halibut some crab	crab	
Effects on habitat	<p>Bottom trawl disturbance of benthic habitat, modification of hard substrate. Long term ecological effects are likely to reduce biodiversity. Incidental catch of living substrates (corals, anemones, sponges, and sea whips) and modification to non-living substrates.</p> <p>Some disturbance with similar effects as bottom trawl (although on a smaller scale). Incidental catch of living substrates (mostly anemones and sponges) and modification to non-living substrates.</p> <p>Significant negative impacts to benthic habitat is unlikely.</p>			

Table 6.3. Portion of the catch of BSAI and GOA groundfish in Steller sea lion critical habitat by gear type (average from 1995-1999).

Catch of groundfish in Steller sea lion critical habitat				
Area	All gear	Trawl	Pot	Hook-and-line
BSAI inside critical habitat around rookeries and haulouts only	14%	13%	63%	18%
BSAI inside critical habitat around rookeries and haulouts plus special foraging areas	49%	50%	81%	27%
GOA inside critical habitat around rookeries and haulouts only	48%	51%	60%	25%
GOA inside critical habitat around rookeries and haulouts plus special foraging areas	54%	58%	71%	25%

Table 6.4. Amounts of groundfish harvested on observed vessels and in hauls sampled by observers compared with amounts estimated using the “blend” catch estimation procedure. Recall from chapter 2 that the “blend” approach consists of a set of rules for determining whether total catch is estimated from observer data or from the fishing vessel records. HAL = hook-and-line gear, POT = pot gear, TRW = trawl gear.

FMP Gear	Target	Blend estimate (mt) ¹	Catch on observed vessels (mt) ²	Catch on observed vessels / blend estimate of total ³	Catch in hauls observed (mt) ⁴	Catch in hauls observed / blend estimate of total ⁵
BSAI						
HAL	Pac. Cod	144,912	135,694	94%	95,827	66%
HAL	Sablefish	2,549	1,041	41%	473	19%
HAL	Turbot	4,909	5,387	110%*	2,703	55%
POT	Pac. Cod	22,639	7,359	33%	5,511	24%
TRW	Atka Mack.	72,379	73,385	101%*	51,599	71%
TRW	Pac. Cod	137,930	126,581	92%	89,175	65%
TRW	O. Flats	3,938	4,199	107%*	2,406	61%
TRW	Rockfish	12,283	11,989	98%	9,023	73%
TRW	Flathead	19,671	14,182	72%	8,010	41%
TRW	Pollcock	1,008,898	876,911	87%	634,683	63%
TRW	Rock Sole	57,928	59,342	102%*	31,742	55%
TRW	Yellowfin	248,865	237,625	95%	145,362	58%
	Totals	1,736,901	1,553,695	89%	1,076,514	62%
GOA						
HAL	Pac. Cod	11,511	1,667	14%	984	9%
HAL	Rockfish	526	19	4%	15	3%
HAL	Sablefish	14,963	3,139	21%	1,244	8%
POT	Pac. Cod	9,419	355	4%	257	3%
TRW	Pac. Cod	53,128	11,020	21%	8,844	17%
TRW	Deep Flat	7,157	3,225	45%	1,540	22%
TRW	Shallow Flat	10,068	2,523	25%	1,706	17%
TRW	Rockfish	20,051	16,369	82%	9,599	48%
TRW	Flathead	4,137	1,980	48%	1,065	26%
TRW	Other Spp.	857	61	7%	47	5%
TRW	Pollcock	87,999	31,295	36%	27,829	32%
TRW	Rex Sole	8,574	5,493	64%	2,956	34%
	Totals	228,390	77,146	34%	56,086	26%

¹ Groundfish metric tons from the blend database.

² Groundfish metric tons from observer official total catch -- all hauls/sets while the observer is onboard, includes observer transcription of skipper estimates for hauls not independently estimated by the observer.

³ Percent of observer official total catch compared to blend total catch estimate. This indicates the proportion of groundfish harvested on observed vessels.

⁴ Groundfish metric tons from hauls actually sampled by the observer. On trawl vessels, a single observer can typically sample 40-60 percent of the hauls. These are the weights of the haul/set from which a sample was taken, not the weight of the sample.

⁵ Percentage of weight of sampled hauls compared to the blend total catch estimate.

* Indicates that the catch estimate from the observer exceeded the catch estimated using the blend approach.

Table 6.5. Summary of the spawning and total biomass in 1999 of a fished stock relative to an unfished stock

Species or species group	1999 spawning biomass/unfished stock	1999 total biomass/unfished stock
EBS Pollock	43%	51%
EBS Pacific cod	50%	50%
EBS Atka Mackerel	66%	56%
All EBS Species	54%	58%
GOA Pollock and Peod	59%	46%
All GOA and EBS Combined	54%	58%

Table 6.6. Scores based on answers to questions about competitive interactions between target fisheries and the western stock of Steller sea lions in the Bering Sea/Aleutian Islands and Gulf of Alaska fishery management areas.

Fished Species or Target Fishery	Bering Sea/ Aleutian Islands	Gulf of Alaska
Pollock	8	8
Pacific cod	8	8
Sablefish	0	0
Atka mackerel	8	0
Yellowfin sole	0	1
Rock sole	1	1
Greenland turbot	1	1
Arrowtooth flounder	2	2
Flathead sole	0	1
Other flatfish	1	1
Pacific ocean perch	1	1
Other red rockfish	1	n/a
Sharpchin/northern rockfish	1	1
Shoortraker/rougheye rockfish	1	0
Squid	2	n/a
Other species	1	1
Flatfish, Deep	n/a	0
Flatfish, Shallow	n/a	1
Rex sole	n/a	0
Rockfish, other slope	n/a	0
Rockfish, pelagic shelf	n/a	1
Rockfish, demersal shelf	n/a	1
Thornyhead	n/a	0
Forage fish	2	2

n/a = not applicable; this target fishery definition is not applicable in this fishery management area.

Table 6.7. Permitted seafood processing facilities in the action area. Data from the Alaska Division of Environmental Health (available through www.state.ak.us).

Location of Facility	Canneries	Land-based	Vessel	Direct-Marketing
Adak		1		
Anchorage		20	5	5
Chignik	1			
Cordova	4	5	1	2
Dillingham	2	2		
Egegik	1	1	1	
Kenai - Homer	1	22	2	4
King Cove	1		1	
King Salmon	1	5		2
Kodiak	4	12	8	1
Larsen Bay	1			
Ninilchik	1			
Seward	2	3		2
Unalaska		6	2	
Valdez	1	3	1	3
Totals	20	80	21	19

Table 9.1. Area (in km²) of CH-RFRPA areas, their status relative to being closed or open to regulated pollock, Pacific cod, and Atka mackerel fisheries, and the fishery management region or 3-digit area they are within. Percent of total CH-RFRPA area (including CH foraging areas and the SCA) closed and open are also shown

Fishery Region/Area	CH-RFRPA Area	Status		Percent		
		Closed	Open	Closed	Open	
EBS	7	166	20,579	20,746	1%	99%
	8	54,390		54,390	100%	0%
	9	37,287		37,287	100%	0%
EBS Total		91,844	20,579	112,423	82%	18%
610	12	1,407	37,530	38,937	4%	96%
	13	40,587		40,587	100%	0%
	13	20,576		20,576	100%	0%
610 Total		62,570	37,530	100,100	63%	37%
620	5	662	14,310	14,971	4%	96%
	6	13,854		13,854	100%	0%
	10	7,362		7,362	100%	0%
610 Total	11	8,491		8,491	100%	0%
	3	30,368	14,310	44,677	68%	32%
	3	395	21,623	22,018	2%	98%
620 Total	4	17,261		17,261	100%	0%
	5	174	3,663	3,837	5%	95%
	1	17,830	25,286	43,116	41%	59%
630	1	501	3,536	4,037	12%	88%
	2	31,364		31,364	100%	0%
	3	457	7,599	8,056	6%	94%
630 Total		32,322	11,135	43,457	74%	26%
GOA Total	1	406	11,781	12,187	3%	97%
		80,926	62,512	143,437	56%	44%
Grand Total		235,339	120,620	355,960	66%	34%

Table 9.2. Description of CH-RFRPA areas 1-13 shown in Figures 10-1, 10-2, and 10-3.

Area	Description
1	All waters 20 nm seaward of sites in area 1 west to 148°45'W and outside of statistical areas 639 and 649
2	All waters 20 nm seaward of sites in area 2 east to 148°45'W, in the Shelikof Strait critical habitat foraging area east of 154°W, and on the east side of Kodiak Island south to a line connecting the following 2 points: 57°31'3" N 152°17'48"W 57°24'36"N 151°40'29"W
3	All waters 20 nm seaward of sites in area 3 north on the east side of Kodiak Island to a line connecting the above 2 points, and in the Shelikof Strait critical habitat foraging area west of 154°W
4	All waters 20 nm seaward of sites in area 4 north to the southern boundary of the Shelikof Strait critical habitat foraging area
5	All waters 20 nm seaward of sites in area 5 west to 161°15'W
6	All waters 20 nm seaward of sites in area 6 east to 161°15'W
7	All waters 20 nm seaward of sites in area 7 and in the Sea Lion Conservation Area west to a line connecting the following 2 points: 55°30'N 166°W 54°51'N 164°33'33"W
8	All waters within the southeastern Bering Sea critical habitat foraging area east of management area 518 and west to a line connecting the above 2 points
9	All waters within both management area 518 (Bogostof) and the southeastern Bering Sea critical habitat foraging area
10	All waters 20 nm seaward of sites in area 10 in management area 610
11	All waters 20 nm seaward of sites in area 11 in management area 610
12	All waters 20 nm seaward of sites in area 12, in the Segum Pass critical habitat foraging area, and in statistical area 541
13	All waters 20 nm seaward of sites in area 13 and in statistical areas 542 and 543

Table 9.3 CH-RFRPA sites in the Gulf of Alaska (GOA), eastern Bering Sea (EBS), and Aleutian Islands (AI). CH-RFRPA areas (1-13) and their status relative to constrained fishing for pollock, Pacific cod, and Atka mackerel (open or closed) are listed and shown in Figures 10-1, 10-2 and 10-3. Each sites' status relative to critical habitat (Y), rookery, haulout (H), and the RFRPA/BO (Y) is shown. Sites listed in fishery management area EBS/GOA are located inside the EBS, but near the border with the GOA. Similarly, sites listed as GOA/EBS are located in the GOA, but near the border with the EBS.

CH/RFRP Area	Open (O) or Closed (C)	Site Name	Rookery or Haulout (H)	Critical Habitat	RFRPA	Fishery Mgt. Area
1	O	CAPE ST. ELIAS	H	Y	Y	GOA
1	O	HOOK POINT	H	Y	Y	GOA
1	O	MIDDLETON ISLAND	H	Y		GOA
1	O	CAPE HINCHINBROOK	H		Y	GOA
1	O	SEAL ROCKS	Rookery	Y	Y	GOA
1	O	GLACIER ISLAND	H		Y	GOA
1	O	WOODED ISLAND (FISH)	Rookery	Y	Y	GOA
1	O	POINT ELEANOR	H	Y		GOA
1	O	THE NEEDLES	H	Y	Y	GOA
1	O	PERRY ISLAND	H	Y		GOA
1	O	POINT ELRINGTON	H	Y	Y	GOA
2	C	RUGGED ISLAND	H		Y	GOA
2	C	CHISWELL ISLANDS	H	Y	Y	GOA
2	C	SEAL ROCKS (KENAI)	H	Y		GOA
2	C	STEEP POINT	H		Y	GOA
2	C	OUTER (PYE) ISLAND	Rookery	Y	Y	GOA
2	C	GORE POINT	H	Y		GOA
2	C	PERL	H		Y	GOA
2	C	NAGAHUT ROCKS	H	Y		GOA
2	C	MARMOT	Rookery	Y	Y	GOA
2	C	SEA LION ROCKS	H	Y	Y	GOA
2	C	SUGARLOAF	Rookery	Y	Y	GOA
2	C	KODIAK/CAPE CHINIYAK	H	Y	Y	GOA
2	C	SUD/SUD ISLAND	H	Y		GOA
2	C	LONG	H	Y	Y	GOA
2	C	SEA OTTER ISLAND	H	Y	Y	GOA
2	C	USHAGAT/SW	H	Y	Y	GOA
2	C	LATAX ROCKS	H	Y	Y	GOA
2	C	CAPE DOUGLAS	H	Y	Y	GOA
2	C	SHAKUN ROCK	H	Y	Y	GOA
2	C	KODIAK/CAPE UGAT	H	Y	Y	GOA
3	O	UGAK	H	Y	Y	GOA
3	O	KODIAK/GULL POINT	H	Y	Y	GOA
3	O	KODIAK/CAPE BARNABAS	H	Y	Y	GOA
3	O	TWO HEADED ISLAND	H	Y	Y	GOA
3	O	SITKINAK/C. SITKINAK	H	Y	Y	GOA
3	O	CAPE GULL	H	Y	Y	GOA
3	O	CAPE KULIAK	H	Y	Y	GOA
3	O	TAKLI	H	Y	Y	GOA
3	O	KODIAK/CAPE IKOLIK	H	Y	Y	GOA
3	O	PUALE BAY	H	Y	Y	GOA
4	C	CHIRIKOF	Rookery	Y	Y	GOA
4	C	NAGAI ROCKS	H	Y	Y	GOA
4	C	CHOWIET	Rookery	Y	Y	GOA
4	C	SUTWIK	H	Y	Y	GOA

CH/FRP Area	Open (O) or Closed (C)	Site Name	Rookery or Haulout (H)	Critical Habitat	RFRPA	Fishery Mgt. Area
4	C	LIGHTHOUSE ROCKS	H	Y	Y	GOA
4	C	KAK	H		Y	GOA
5	O	MITROFANIA	H		Y	GOA
5	O	SPITZ	H	Y	Y	GOA
5	O	ATKINS	Rookery	Y	Y	GOA
5	O	CASTLE ROCK	H	Y	Y	GOA
5	O	CHERNABURA	Rookery	Y	Y	GOA
5	O	THE WHALEBACK	H	Y	Y	GOA
5	O	NAGAI	H	Y	Y	GOA
5	O	SEA LION ROCKS	H	Y	Y	GOA
5	O	JUDE	H	Y	Y	GOA
6	C	OLGA ROCKS	H		Y	GOA
6	C	SUSHILNOI ROCKS	H		Y	GOA
6	C	PINNACLE ROCK	Rookery	Y	Y	GOA
6	C	CATON	H	Y	Y	GOA
6	C	CLUBBING ROCKS	Rookery	Y	Y	GOA
6	C	SOUTH ROCKS	H	Y	Y	GOA
6	C	BIRD	H	Y	Y	GOA
7	O	AMAK+ROCKS	H	Y	Y	EBS
7	O	SEA LION ROCK (AMAK)	Rookery	Y	Y	EBS
8	C	UNIMAK/CAPE SARICHEF	H		Y	EBS/GOA
8	C	AKUN/BILLINGS HEAD	Rookery	Y	Y	EBS/GOA
8	C	AKUTAN/REEF-LAVA	H	Y	Y	EBS/GOA
8	C	UNALASKA/BISHOP PT	H		Y	EBS
8	C	CAPENEWENHAM	H	Y	Y	EBS
8	C	ST.LAWRENCE-SW/CAPE	H	Y	Y	EBS
8	C	ST. LAWRENCE-S.PUNUK	H	Y	Y	EBS
8	C	ST. GEORGE-DALNOI PT	H	Y	Y	EBS
8	C	ST. GEORGE-S. ROOKRY	H	Y	Y	EBS
8	C	ST. PAUL-SEA LION RK	H	Y	Y	EBS
8	C	ST. PAUL-NE POINT	H	Y	Y	EBS
8	C	ROUND (WALRUS IS)	H	Y	Y	EBS
8	C	HALL	H	Y	Y	EBS
8	C	WALRUS	Rookery	Y	Y	EBS
9	C	BOGOSLOF/FIRE ISLAND	Rookery	Y	Y	EBS
9	C	UMNAK/CAPE ASLIK	H	Y	Y	EBS
9	C	ADUGAK	Rookery	Y	Y	EBS/GOA
9	C	KAGAMIL	H	Y	Y	EBS/GOA
9	C	ULIAGA	H	Y	Y	EBS/GOA
10	C	ROUND	H		Y	GOA/EBS
10	C	UGAMAK	Rookery	Y	Y	GOA/EBS
10	C	AIKTAK	H	Y	Y	GOA/EBS
10	C	TIGALDA/ROCKS NE	H	Y	Y	GOA/EBS
10	C	TANGINAK	H	Y	Y	GOA/EBS
10	C	ROOTOK	H	Y	Y	GOA/EBS
10	C	AKUTAN/CAPE MORGAN	Rookery	Y	Y	GOA/EBS
10	C	OLD MAN ROCKS	H	Y	Y	GOA/EBS
10	C	UNALASKA/CAPE	H	Y	Y	GOA/EBS
11	C	UNALASKA/CAPE IZIGAN	H		Y	GOA/EBS
11	C	EMERALD	H	Y	Y	GOA/EBS
11	C	POLIVNOI ROCK	H	Y	Y	GOA/EBS

CH/RFRP Area	Open (O) or Closed (C)	Site Name	Rookery or Haulout (H)	Critical Habitat	RFRPA	Fishery Mgt. Area
11	C	OGCHUL	Rookery	Y	Y	GOA/EBS
11	C	SAMALGA	H	Y	Y	GOA/EBS
11	C	CHUGINADAK	H	Y	Y	GOA/EBS
12	O	YUNASKA	Rookery	Y	Y	AI
12	O	CHAGULAK	H	Y	Y	AI
12	O	AMUKTA AND ROCKS	H	Y	Y	AI
12	O	SEGUAM/OTHER	H	Y	Y	AI
12	O	SEGUAM/FINCH POINT	H	Y	Y	AI
12	O	SEGUAM/SADDLERIDGE	Rookery	Y	Y	AI
12	O	AGLIGADAK	Rookery	Y	Y	AI
12	O	AMLIA/EAST	H	Y	Y	AI
12	O	TANADAK (AMLIA)	H	Y	Y	AI
12	O	SAGIGIK	H	Y	Y	AI
12	O	AMLIA/SVIECH. HARBOR	H	Y	Y	AI
12	O	ATK AN. CAPE-C. KOROVIN	H	Y	Y	AI
12	O	KASATOCHI	Rookery	Y	Y	AI
12	O	ANAGAKSIK	H	Y	Y	AI
12	O	GREAT SITKIN	H	Y	Y	AI
12	O	LITTLE TANAGA STRAIT	H	Y	Y	AI
12	O	ADAK/C. YAKAK-LAKE PT	Rookery	Y	Y	AI
13	C	KANAGAN CAPE	H	Y	Y	AI
13	C	KANAGA/SHIP ROCK	H	Y	Y	AI
13	C	BOBROF	H	Y	Y	AI
13	C	TANAGA/BUMPY POINT	H	Y	Y	AI
13	C	GRAMP ROCK	Rookery	Y	Y	AI
13	C	UGIDAK	H	Y	Y	AI
13	C	TAG	Rookery	Y	Y	AI
13	C	KAVALGA	H	Y	Y	AI
13	C	ULAK	Rookery	Y	Y	AI
13	C	UNALGA & DINKUM RKS	H	Y	Y	AI
13	C	AMATIGNAK/NITROF PT.	H	Y	Y	AI
13	C	SEMISOPOCHNOI/POCHNO	Rookery	Y	Y	AI
13	C	SEMISOPOCHNOI/PETREL	Rookery	Y	Y	AI
13	C	AMCHITKA/EAST CAPE	Rookery	Y	Y	AI
13	C	AMCHITKA/C. IVAKIN	H	Y	Y	AI
13	C	AMCHITKA/COLUMN	Rookery	Y	Y	AI
13	C	LITTLE SITKIN	H	Y	Y	AI
13	C	AYUGADAK	Rookery	Y	Y	AI
13	C	RAT	H	Y	Y	AI
13	C	SEGULA/GULA POINT	H	Y	Y	AI
13	C	SEGULA/CHUGUL POINT	H	Y	Y	AI
13	C	TANADAK (KISKA)	H	Y	Y	AI
13	C	KISKA/SIRIUS POINT	H	Y	Y	AI
13	C	KISKA/SOBAKA & VEGA	H	Y	Y	AI
13	C	KISKALIEF COVE	Rookery	Y	Y	AI
13	C	KISKA/CAPE ST STEPHN	Rookery	Y	Y	AI
13	C	BULDIR	Rookery	Y	Y	AI
13	C	SHEMYA	H	Y	Y	AI
13	C	ALAID	H	Y	Y	AI
13	C	AGATTU/CAPE SABAK	Rookery	Y	Y	AI
13	C	ATTU/CHIRIKOF POINT	H	Y	Y	AI
13	C	AGATTU/GILLON PT.	Rookery	Y	Y	AI
13	C	ATTU/CAPE WRANGELL	Rookery	Y	Y	AI

Table 9.4. Seasonal fraction of the biomass of pollock, Pacific cod, and Atka mackerel in critical habitat in the Steller sea lion management area which is open for fishing (see figure 9.1). These fractions are then multiplied by the seasonal apportionment of TAC by management area to get the TAC limit for the specified area.

Area	Seasonal fraction of biomass inside open CH-RFRPA areas			
	A	B	C	D
Eastern Bering Sea (area 7)				
Pollock	.364	.231	.029	.046
Pacific cod	.344	.065	.083	.200
Gulf of Alaska				
Pacific cod	.238	.008	.006	.010
Area 610 (SSL area 5)	.636	.172	.195	.201
Area 620/630 (SSL areas 1,3,5)				
Pollock	.048	.048	.021	.021
Area 610 (SSL area 5)	.107	.107	.046	.046
Area 620 (SSL area 3&5)	.001	.001	.022	.022
Area 630 (SSL area 1&3)	.002	.002	.003	.003
Area 640 (SSL area				
Aleutian Islands (area 12)				
Atka mackerel	.110	.110	.110	.110
Pollock	.042	.049	.058	.054
Pacific cod	.687	.371	.142	.324

Table 9.5. Summary statistics of Steller sea lion count data by area. Data are from the NMFS 2000 Steller sea lion survey.

Block	Area	Non-pups	Non-pup sites	Pups	Pup sites
I	1	2314	9	689	2
	2	2935	21	1458	3
	3	779	9	0	0
	4	1262	8	418	2
	5	2033	12	406	2
	6	2398	7	1087	2
II	7	1204	2	134	1
	8	624	6	56	1
	9	884	6	355	2
	10	1105	7	1063	2
	11	1316	9	42	1
III	12	4925	39	1240	5
	13	3588	23	2425	14

Table 9.6. Summary statistics of the number of Steller sea lion non-pups and pups by block and open/closed areas. Data are from the NMFS 2000 Steller sea lion survey.

Block	Status for Fishing	Non-pup	Pup
I	open	4946	1095
	closed	6595	2963
	% open	43	27
II	open	1204	134
	closed	3929	1516
	% open	23	8
III	open	4925	1240
	closed	3588	2425
	% open	58	34
Total (pooled)	open	11075	2469
	closed	14112	6904
	% open	44	26

Table 9.7. Summary of Steller sea lion non-pup count data in the 13 areas. Count data are from 1991 to 2000 (pers. comm. John Sease, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA).

Area	1991	1992	1994	1996	1998	2000	Trend (r)
1	4276	3956	3344	2302	1790	2134	-0.10
2	5002	4951	4812	3941	2977	2935	-0.07
3	1197	923	1165	822	943	779	-0.04
4	2385	2246	1744	1579	1647	1262	-0.06
5	2524	2417	2727	2523	2814	2033	-0.01
6	2474	2850	2702	2884	2669	2398	-0.01
7	910	1198	1160	1570	1390	1204	0.03
8	303	532	778	659	836	624	0.07
9	1127	1067	921	879	736	884	-0.04
10	1419	1363	1437	1361	1349	1105	-0.02
11	1757	1734	1686	1608	1654	1316	-0.03
12	6049	5254	4877	4620	4969	4925	-0.02
13	7599	7396	6000	5847	5439	3588	-0.07
Total	37022	35887	33353	30595	29213	25187	-0.04

Table 9.8. Summary of Steller sea lion non-pup trend data in the three blocks. Count data are from 1991 to 2000 (pers. comm. John Sease, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA).

Block	Status	Trends (r)	Lower CI	Upper CI
I	open	-0.05	-0.07	-0.03
	closed	-0.05	-0.06	-0.04
II	open	-0.01	-0.03	0.01
	closed	0.0	-0.04	0.05
III	open	-0.02	-0.05	0.01
	closed	-0.07	-0.11	-0.04

Table 9.9. Catch estimates (mt) of pollock, Pacific cod, and Atka mackerel by each target fishery (all gear types) in 1998 and 1999 in the open and closed portions of each block.

Block	Status	Pollock		Pacific cod		Atka mackerel		Total	
		1998	1999	1998	1999	1998	1999	1998	1999
I	Open	82,434	63,964	12,912	11,423			95,346	75,387
	Closed	21,620	13,841	17,045	16,581			38,665	30,421
II	Open	308,467	237,433	18,680	18,247			327,147	255,679
	Closed	358,525	114,460	31,503	28,864	605	1,944	390,028	143,323
III	Open	1,509	27	16,766	18,561	5,523	12,226	18,275	18,588
	Closed	15,712	140	7,795	5,314	38,973	15,318	23,506	5,454

Table 9.10. Possible outcomes of jointly examining whether trends in closed and open areas have improved after implementation of conservation measures.

Outcome	Evidence	Possible conclusions	Supporting evidence	
1	Open better Closed better	Fishery contributed to decline of sea lions	Conservation measures in open areas are adequate	Indication that more fish are available in critical habitat in both closed and open areas
2	Open not better Closed better	Fishery contributed to decline of sea lions	Conservation measures in open areas are not adequate	Indication that more fish are available in critical habitat in only closed areas
3	Open not better Closed not better	Fishery did not contribute to decline of sea lions	Fishery has no effect on sea lions	Indication that more fish are available in critical habitat in both closed and open areas
4	Open better Closed not better	Fishery did not contribute to decline of sea lions	Fishery helps sea lions	

Table 9.11. Statistical power to detect an improvement in the population trend before and after conservation measures are implemented, by block, for 4-8 years of annual counts of non-pups. The improvement in population trend was set at 0.04. The future precision of the abundance estimates was assumed to be the same as observed previously, estimated by the standard error of the Y variable, SE(Y), from the regression on log abundance from 1991 to 2000. This represents the coefficient of variation of the abundance estimates. The significance level was set to 0.10.

Block	Status	SE(Y) (1991-2000)	4 years	5 years	6 years	7 years	8 years
I	Open	0.053	0.41	0.68	0.84	0.92	0.97
	Closed	0.036	0.80	0.95	0.98	1.00	1.00
II	Open	0.056	0.68	0.83	0.91	0.96	0.99
	Closed	0.123	0.42	0.47	0.59	0.64	0.71
III	Open	0.078	0.20	0.33	0.50	0.64	0.78
	Closed	0.106	0.41	0.54	0.63	0.71	0.73

Table 9.12. Probability of making a correct decision after 5 additional annual counts of non-pup are performed (6 years of data), using a significance test. The probability of a correct outcome is, for example, the probability that concludes outcome 1 has occurred when it truly has occurred (e.g., one concludes both the closed and open areas have trends that have improved when they both actually have improved). The probability of not making a major error is, for Outcome 1 and 2, the probability of concluding either 1 or 2, and, for Outcome 3 and 4, the probability of concluding either 3 or 4.

Block	Outcome	Probability of correct outcome	Probability of not making a major error
I	1	0.82	.99
	2	0.91	.98
	3	0.80	.85
	4	0.67	.83
II	1	0.54	.59
	2	0.48	.57
	3	0.64	.82
	4	0.74	.82
III	1	0.33	.63
	2	0.61	.65
	3	0.78	.81
	4	0.41	.80

Table 9.13. Relative loss values for a decision analysis, showing the possible combinations of true conditions (columns) and decision options (rows).

Decision options		True condition			
		Fishery contributes to decline of sea lions		Fishery does not contribute to decline of sea lions	
Both better		0	1	3	3
Closed better	Open not better	1	0	3	3
Both not better		3	3	0	1
Closed not better	Open better	3	3	1	0

Table 9.14. Probability of making a correct decision after 5 additional annual counts of non-pup are performed (6 years of data), using a decision analysis approach with the loss functions specified in Table 9.12.

Block	Outcome	Probability of correct outcome	Probability of not making a major error
I	1	0.96	1.00
	2	0.77	1.00
	3	0.57	0.72
	4	0.69	0.72
II	1	0.90	0.92
	2	0.47	0.92
	3	0.19	0.39
	4	0.38	0.39
III	1	0.79	0.94
	2	0.74	0.94
	3	0.31	0.39
	4	0.34	0.39

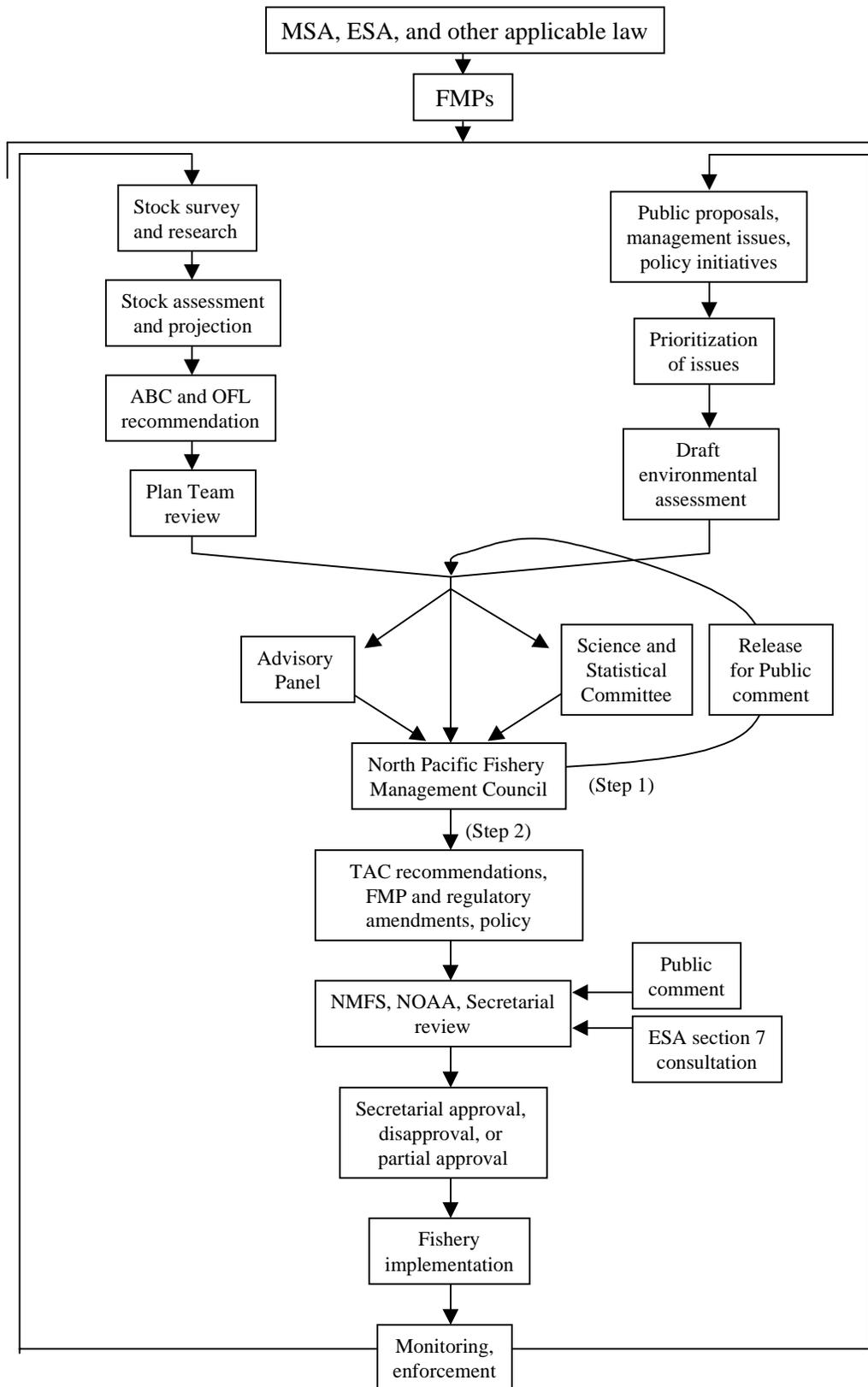


Figure 2.1. Management process for the Alaska groundfish fisheries.

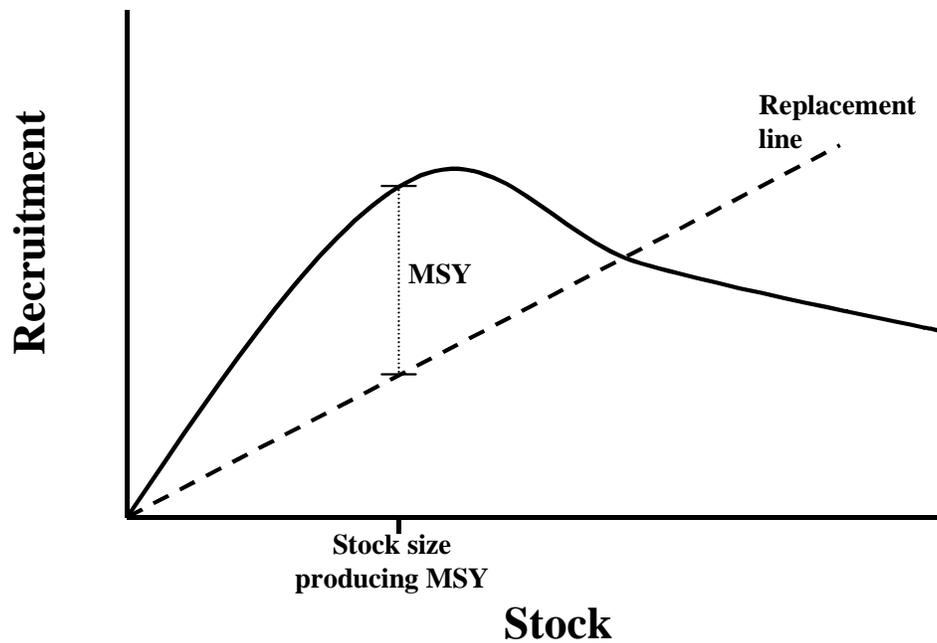


Figure 2.2. Hypothetical Ricker curve showing expected recruitment as a function of stock size. The replacement line indicates the level of recruitment necessary to sustain the population at any particular size. The positive difference between recruitment and the replacement line (to the left of the point where the two cross) indicates recruitment in excess of that needed to replace the stock, and is considered surplus in a single-species context. The maximum excess is the maximum sustainable yield (MSY) and the stock size that results in the maximum excess is the stock size producing MSY.

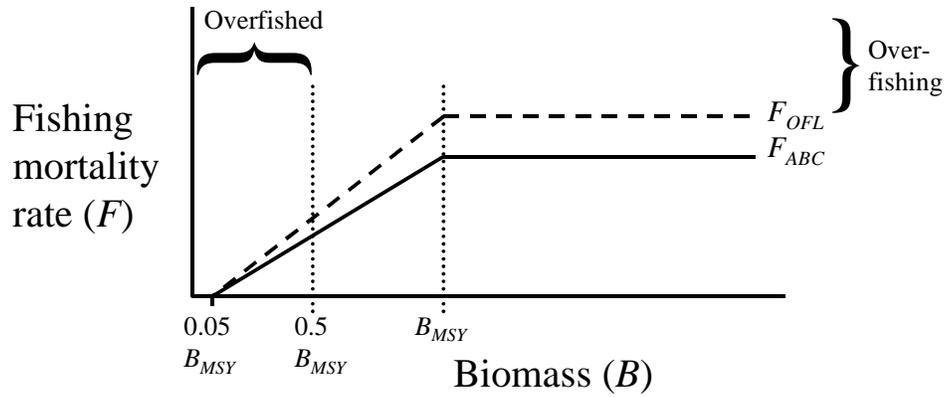


Figure 2.3. Graphic illustration of “overfishing” and “overfished.” Overfishing occurs when the fishing mortality rate exceeds a prescribed maximum rate. Overfished indicates that the fished stock has declined below a certain level. The illustration indicates that the level is $\frac{1}{2} B_{MSY}$, which may or may not be the actual level. The actual level is determined as the maximum of either $\frac{1}{2} B_{MSY}$ or the smallest level at which the population would be expected to recover to B_{MSY} within 10 years of random recruitment and fishing at F_{OFL} .

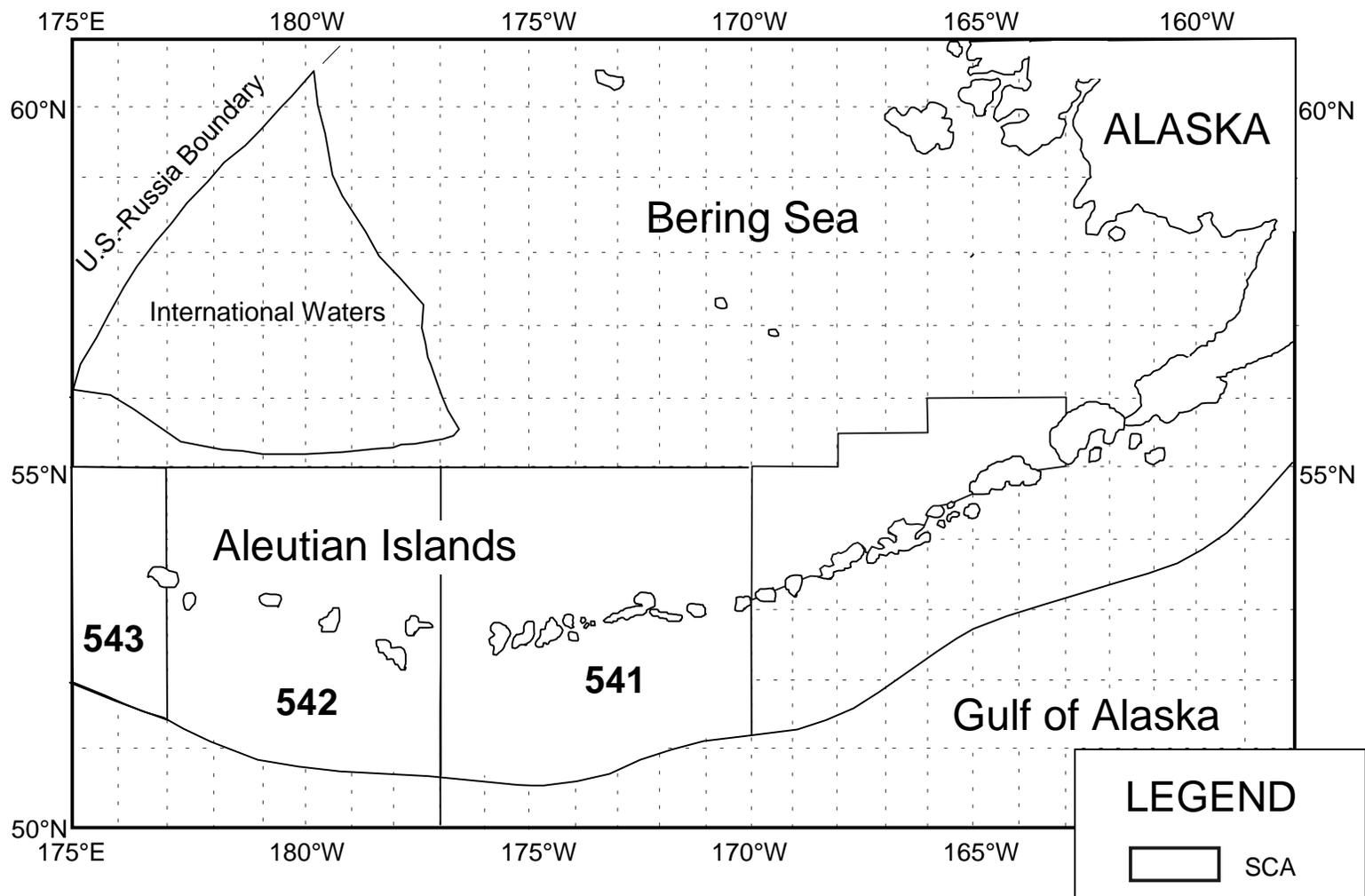


Figure 2.4. Management areas for the BSAI groundfish fishery. The SCA is used for pollock fishing only.

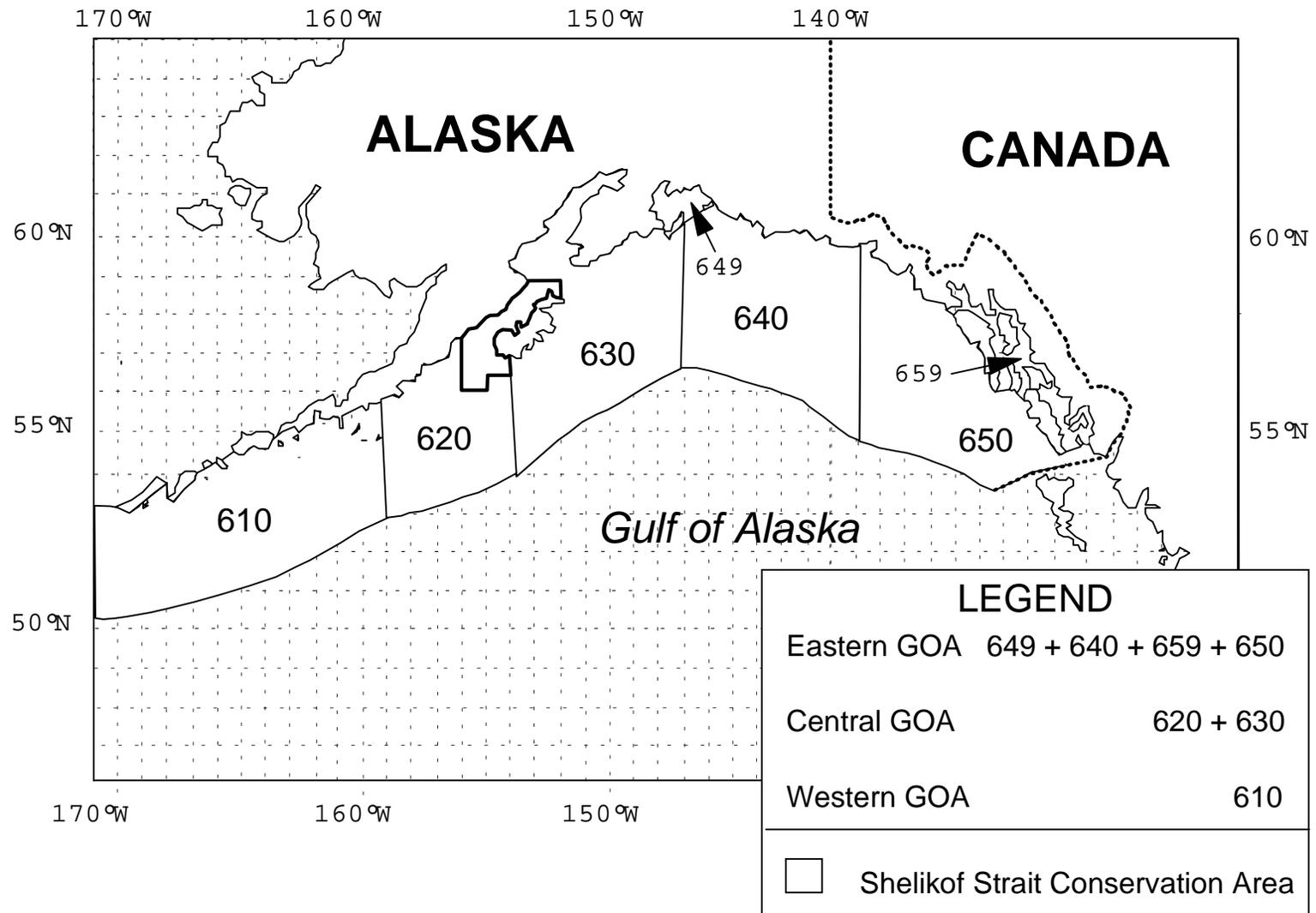


Figure 2.5. Management areas for the GOA groundfish fishery. The Shelikof Strait area is used for pollock fishing in the A and B seasons only.

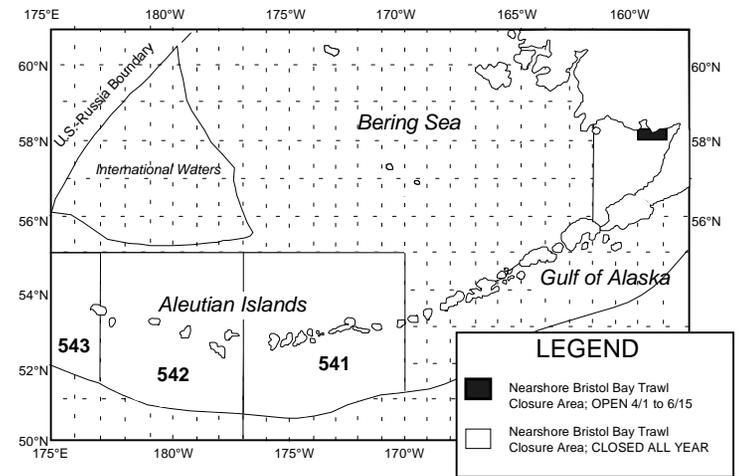
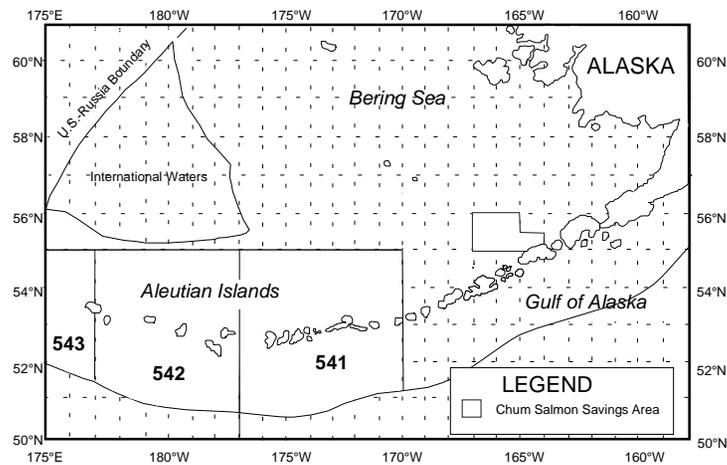
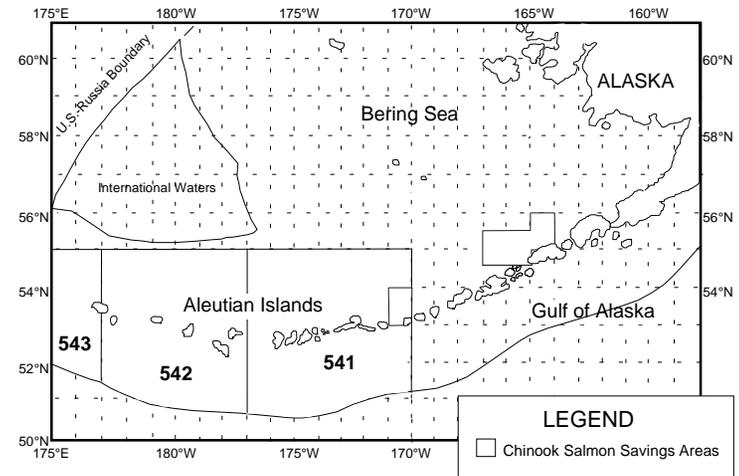
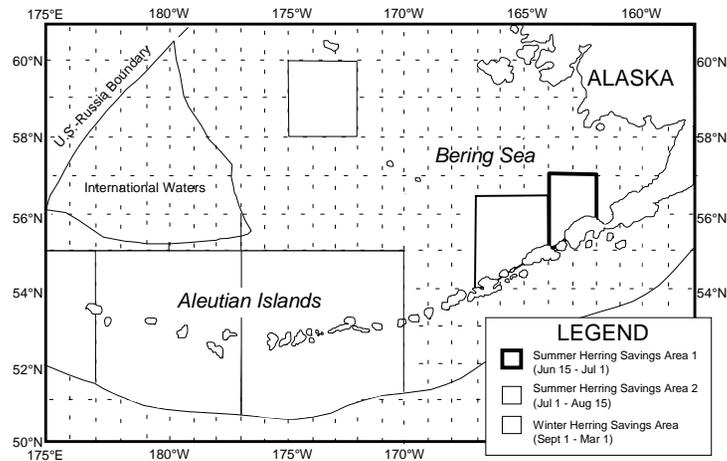


Figure 2.6. Locations used for time/area management of the BSAI and GOA groundfish fisheries: Herring Savings Areas (upper left), Chinook Salmon Savings Area (upper right), Chum Salmon Savings Area (lower left), and Bristol Bay Trawl Closure Areas (lower right). (continued next page)

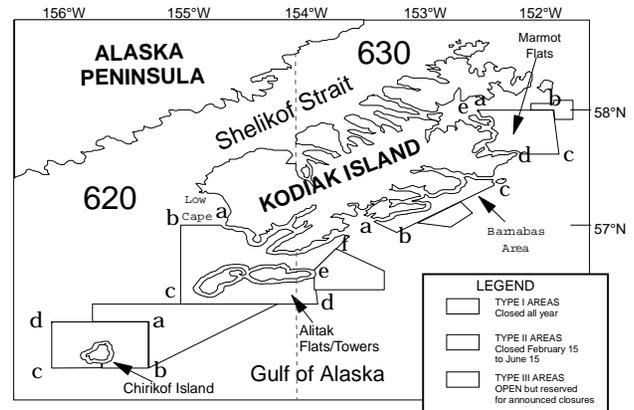
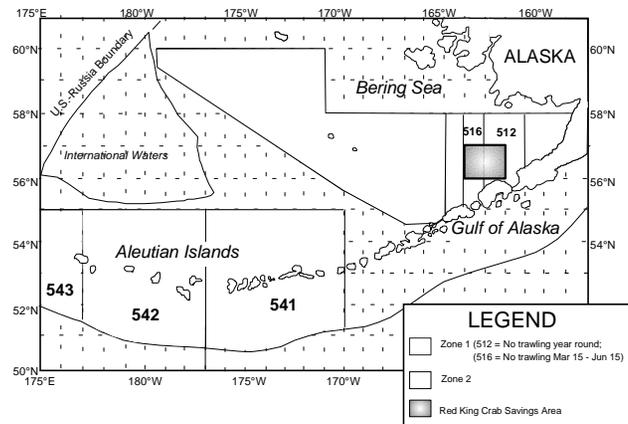
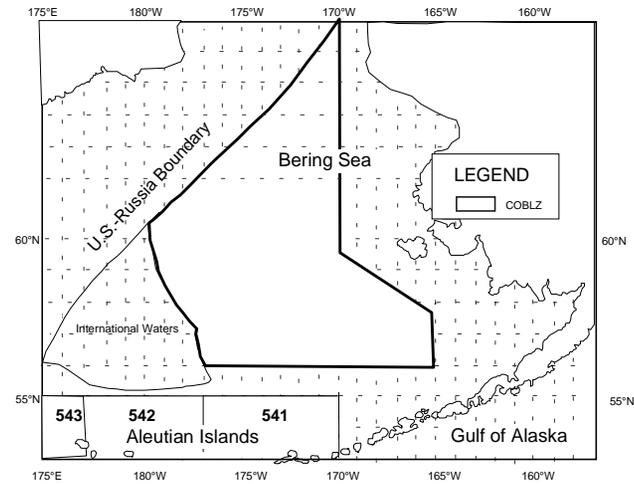
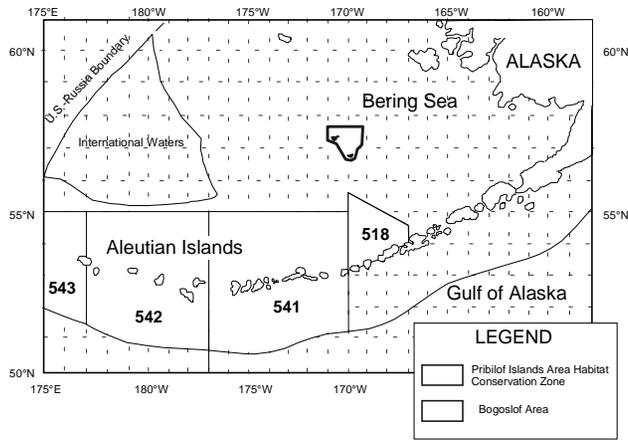
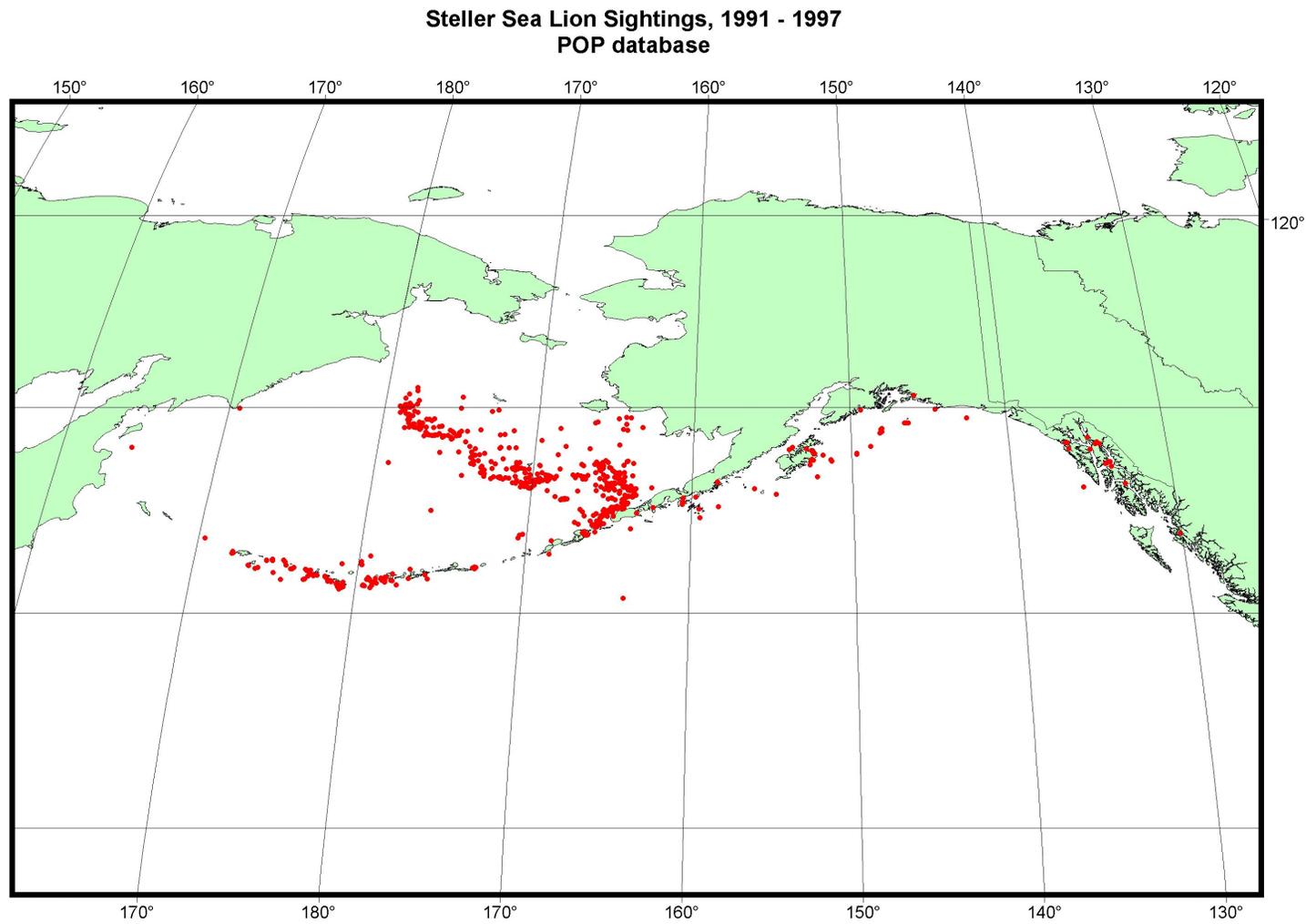


Figure 2.6. (continued) Locations used for time/area management of the BSAI and GOA groundfish fisheries: Pribilof Islands Habitat Conservation Area and Bogoslof area (Bogoslof closed to pollock fishing only; upper left), C. Opilio Bycatch Limitation Zone (upper right), Prohibited Species Bycatch Limitation Zones (for red king crab and *C. bairdi* Tanner crab; lower left), and Kodiak Island Areas for crab protection (lower right).

Figure 4.2. Sighting locations for Steller sea lions in the BSAI and GOA based on data from the Platforms-of-Opportunity Program, 1958-1995.



Data source: NMML POP database, 1991-1997
Prepared by SAM, 22Nov 2000

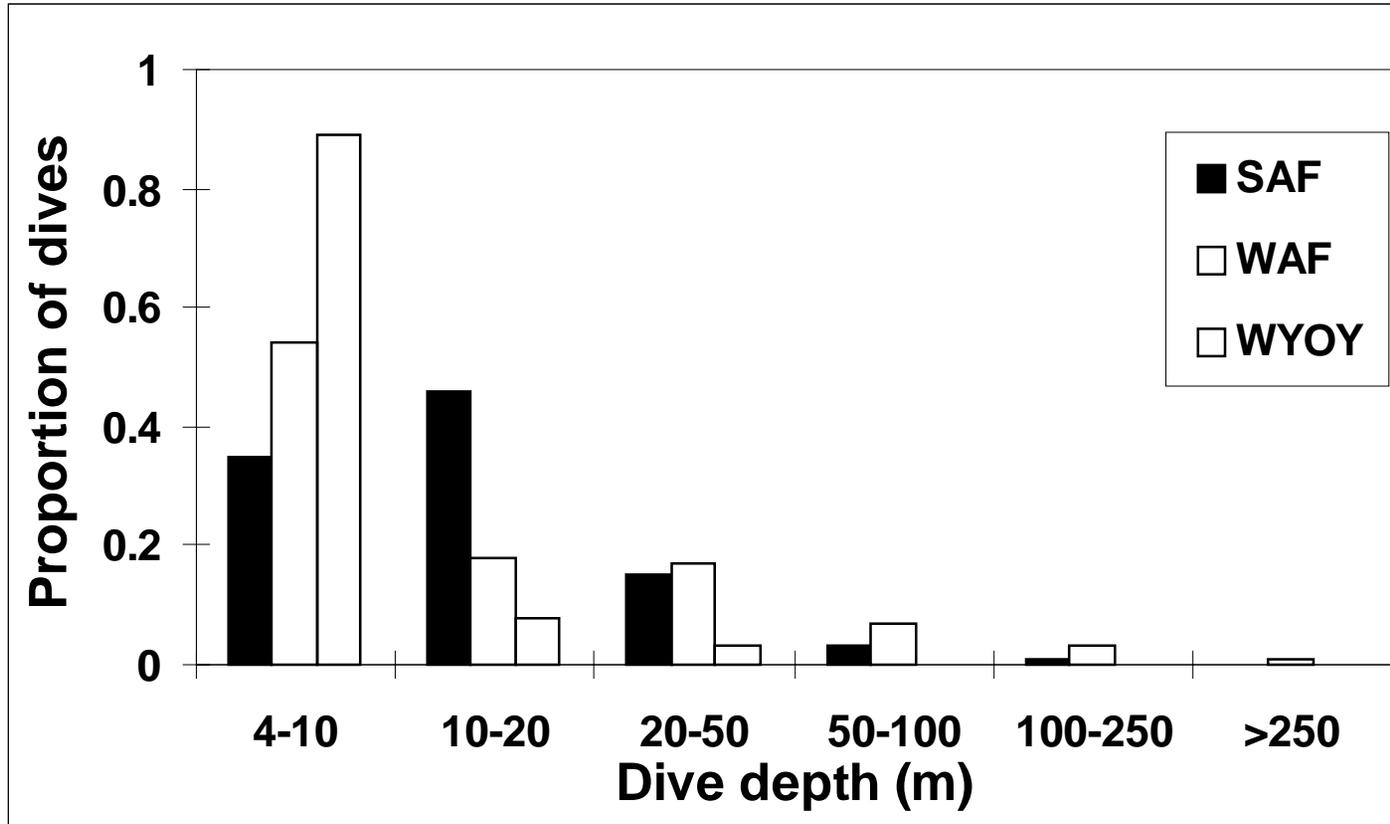


Figure 4.3. Portion of dives by depth range for young-of-the-year (WYOY) and adult female Steller sea lions in summer (SAF) and winter (WAF) tracked during 1990-1993 (from Merrick and Loughlin 1997).

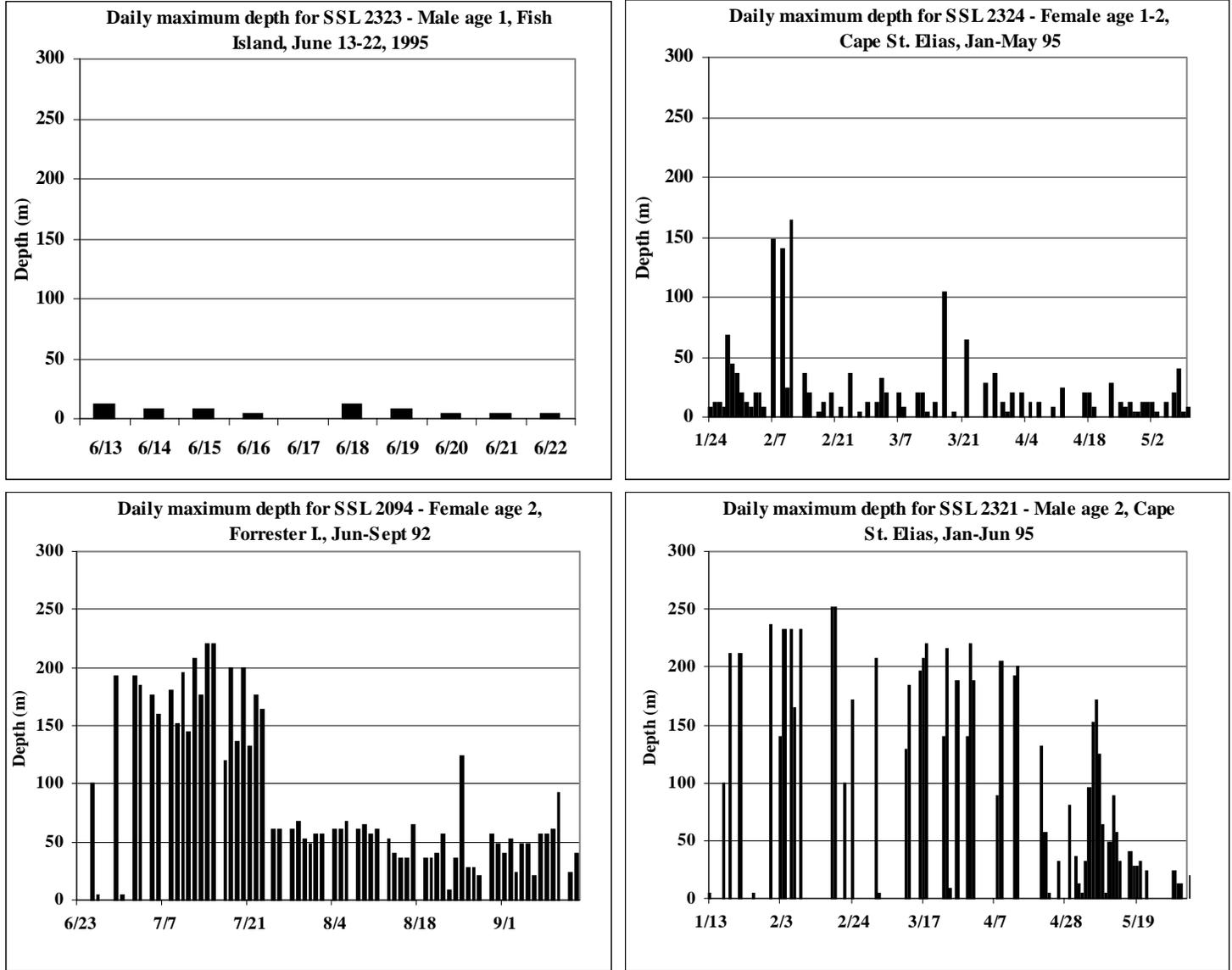


Figure 4.4. Maximum daily dive depths for four juvenile Steller sea lions (based on data from U. Swain, Alaska Department of Fish and Game).

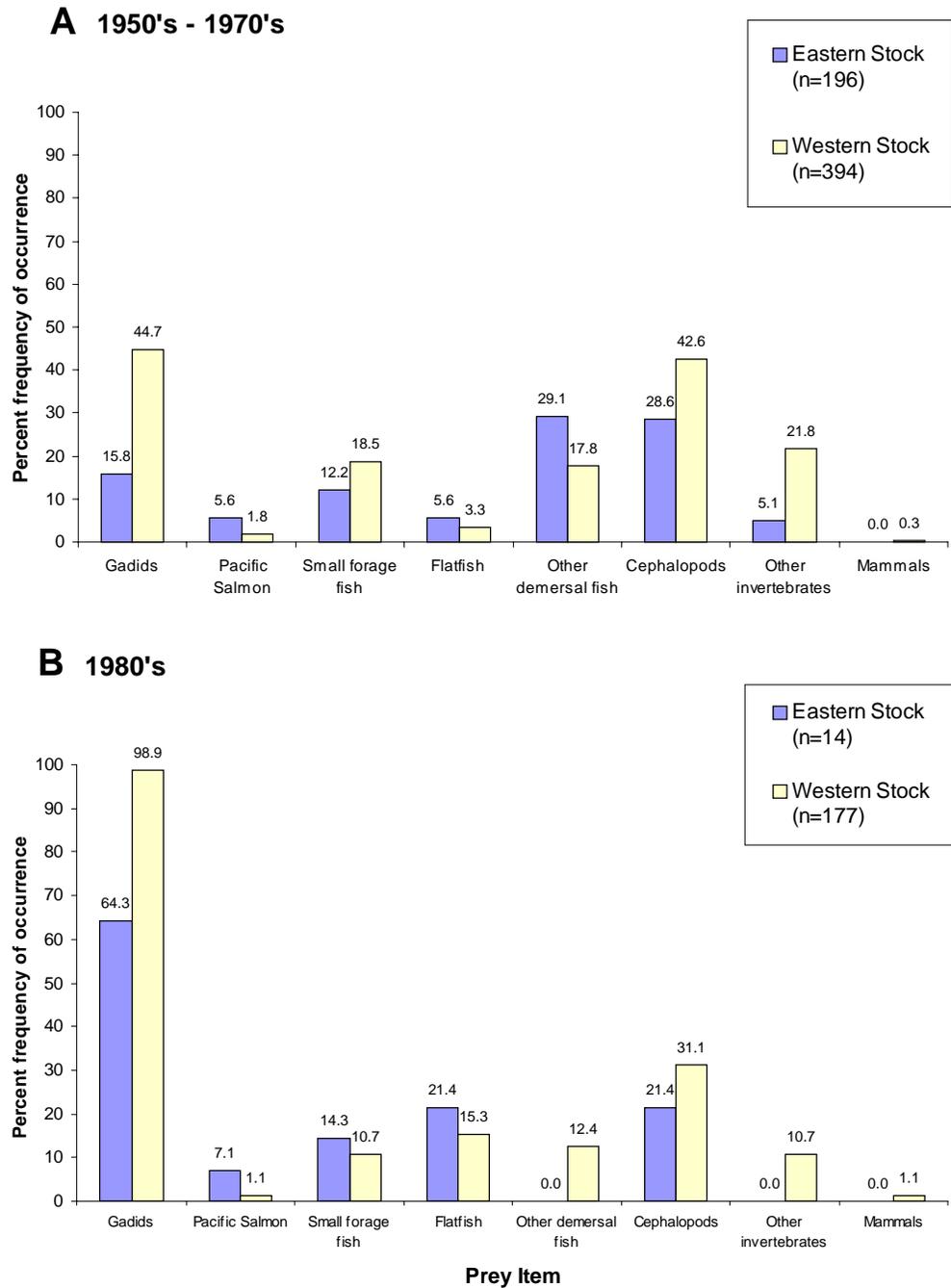
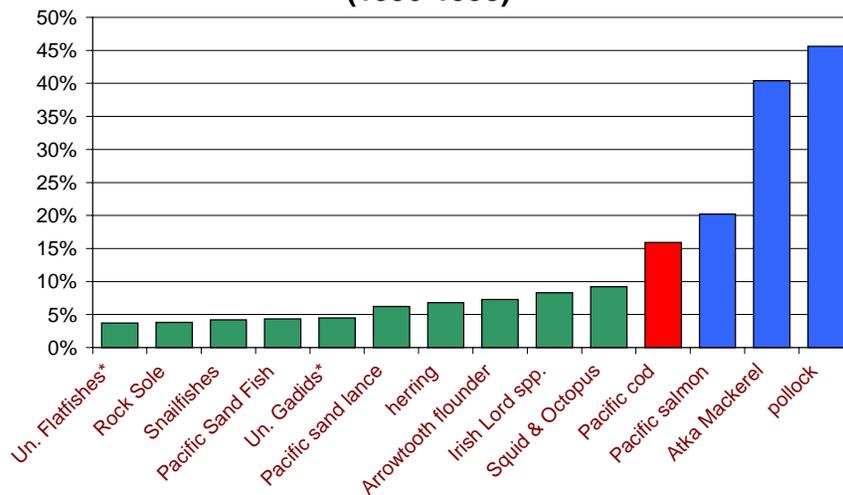


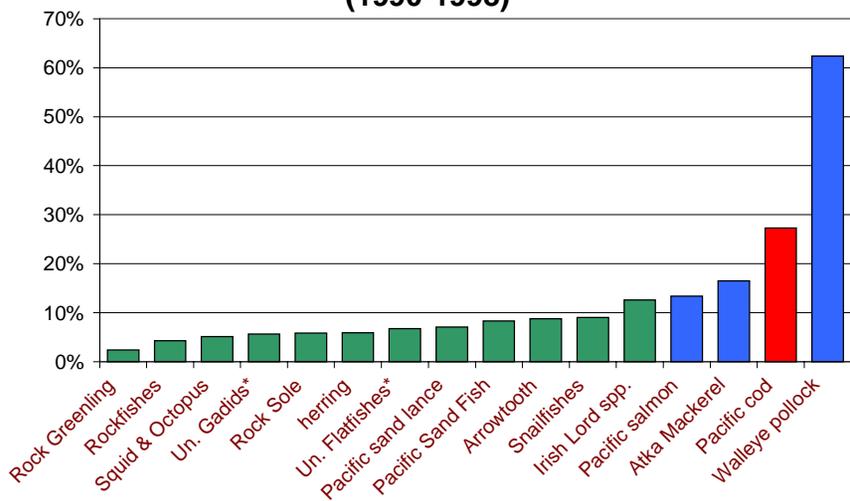
Figure 4.5. Frequency of occurrence of Steller sea lion prey items found in stomach samples (n= 781 stomachs with prey remains) collected in studies conducted from 1956 to 1986 in locations ranging from the Kuril Islands to California. Prey taxa are grouped following Merrick and Calkins (1996) with the addition of the Other invertebrate and Mammal categories. Panel A shows the eastern and western portions of the range from the 1950's through the 1970's. Panel B shows the the same geographic areas during the 1980's.

Figure 4.6. Percent frequency of occurrence of prey items identified in Steller sea lion scat samples form 1990-1998.

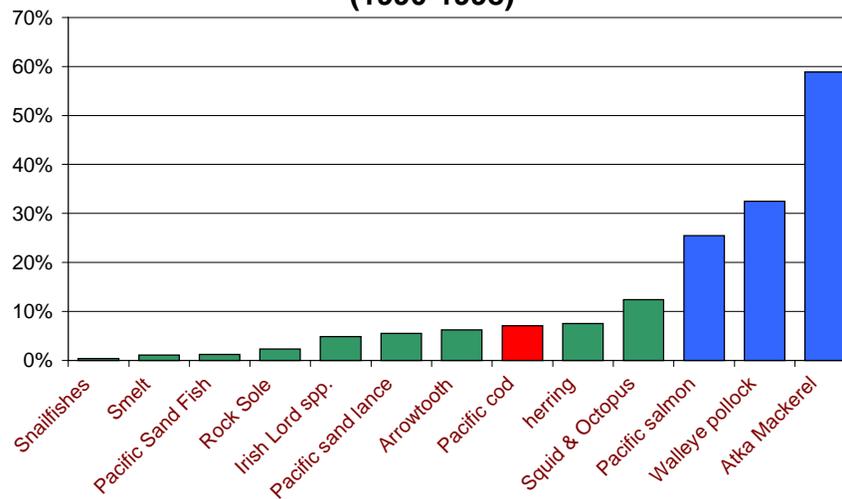
Prey Items in Steller Sea Lion Diet - All Year (1990-1998)



Prey Items in Steller Sea Lion Diet - Winter (1990-1998)



Prey Items in Steller Sea Lion Diet - Summer (1990-1998)



Winter

Percent Frequency of Occurrence of Top Three Prey Items found in Steller Scats collected December through April, 1990 – 1998
(n = number of scats collected containing identifiable prey items.)

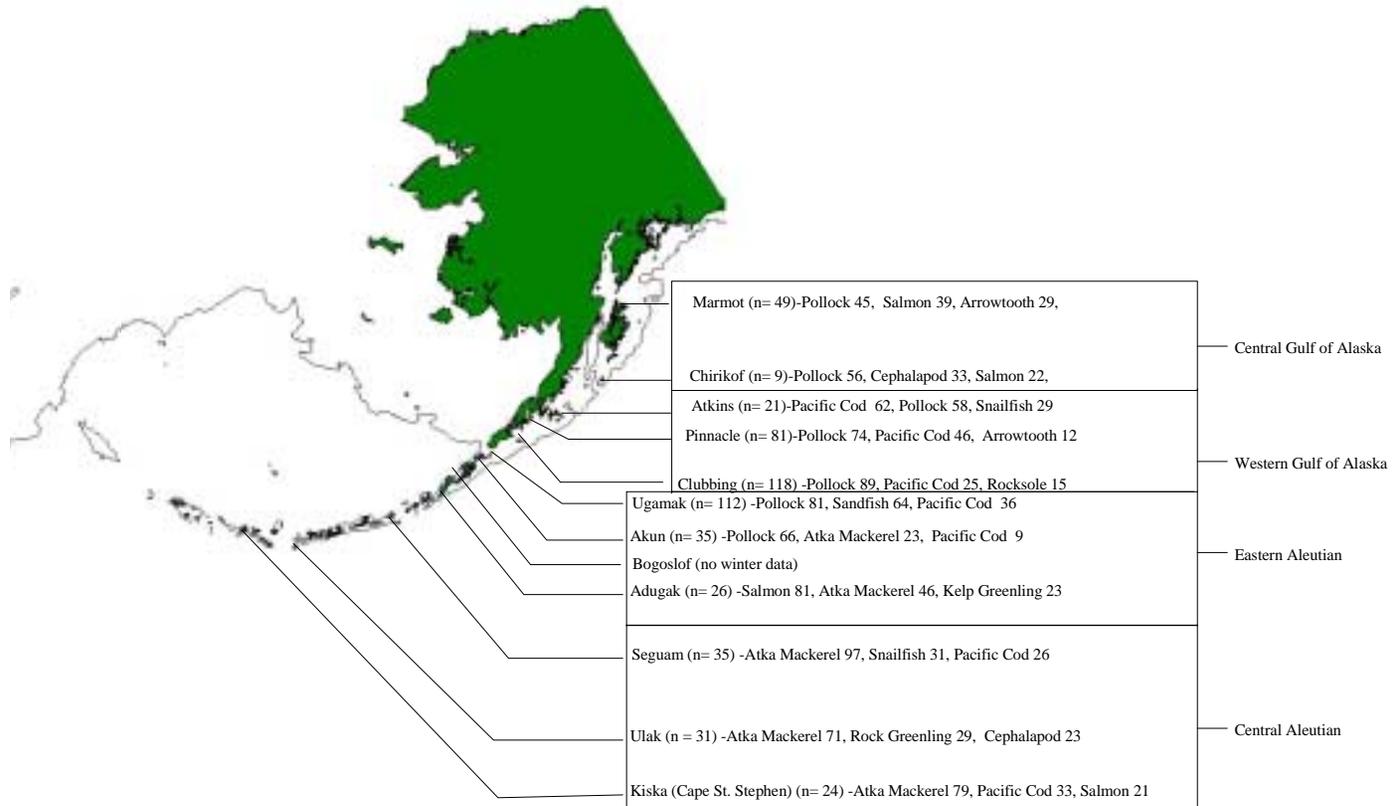


Figure 4.7a. Percent frequency of occurrence of prey items identified in Steller sea lion scat collections in winter from 1990-1998.

Summer

Percent Frequency of Occurrence of Top Three Prey Items found in Steller Scats collected June through August, 1990 – 1998
(n = number of scats collected containing unidentifiable prey items.)

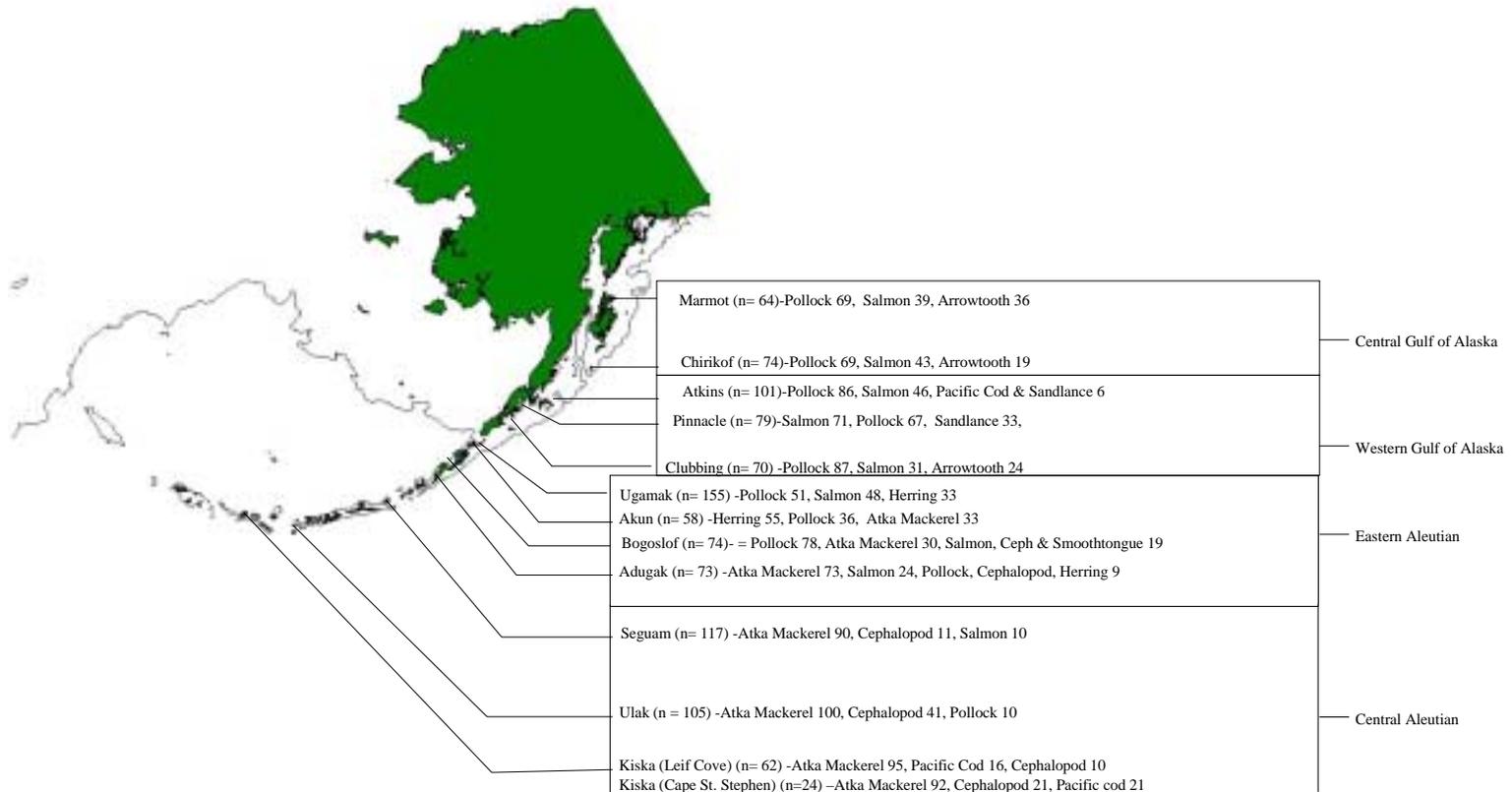


Figure 4.7b. Percent frequency of occurrence of prey items identified in Steller sea lion scat collections in summer from 1990-1998.

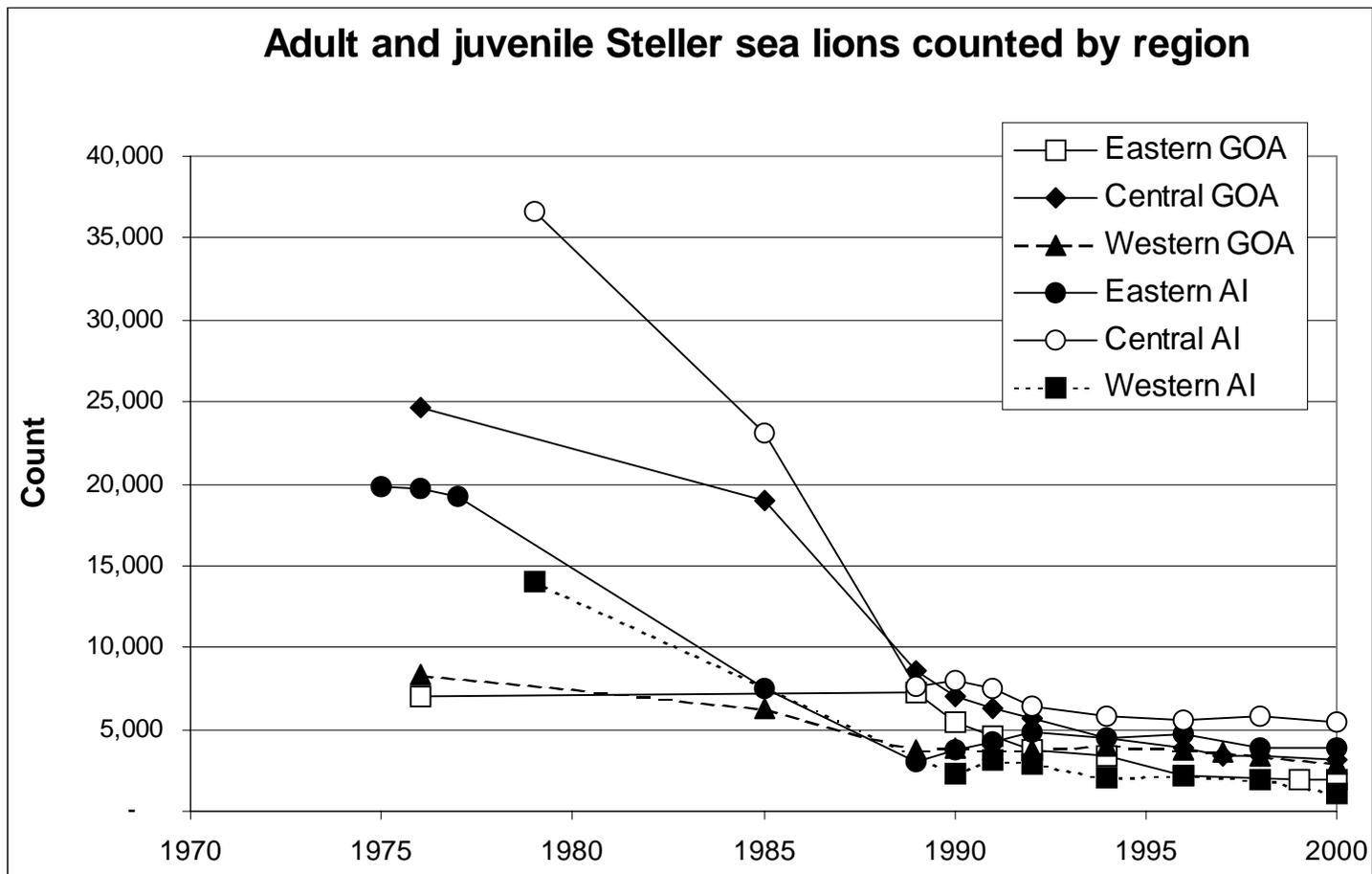


Figure 4.8. Counts of adult and juvenile Steller sea lions in the western population (by region) from the late 1970s to 2000.

Steller Sea Lion Critical Habitat

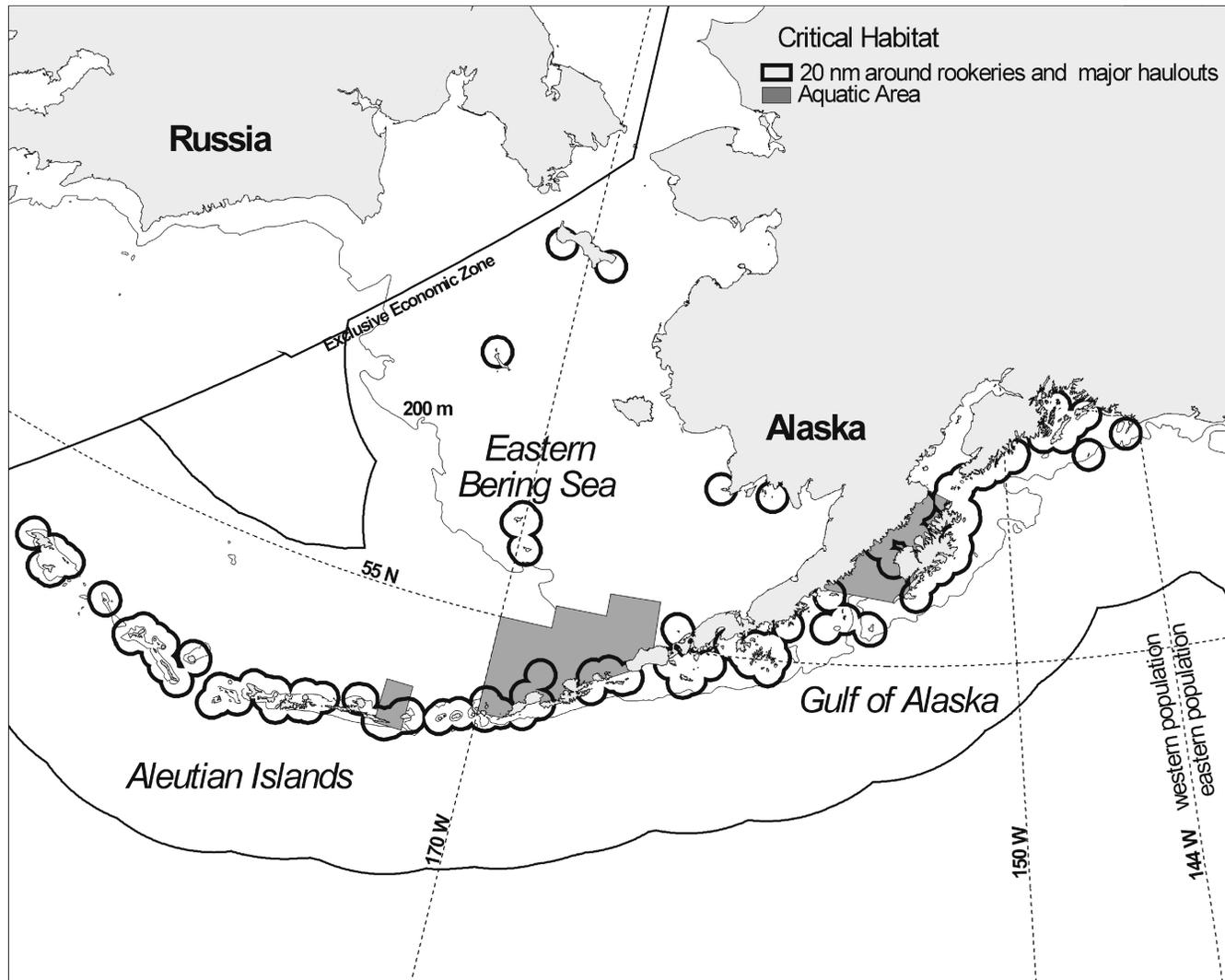


Figure 4.9. Critical habitat for the western population of Steller sea lions.

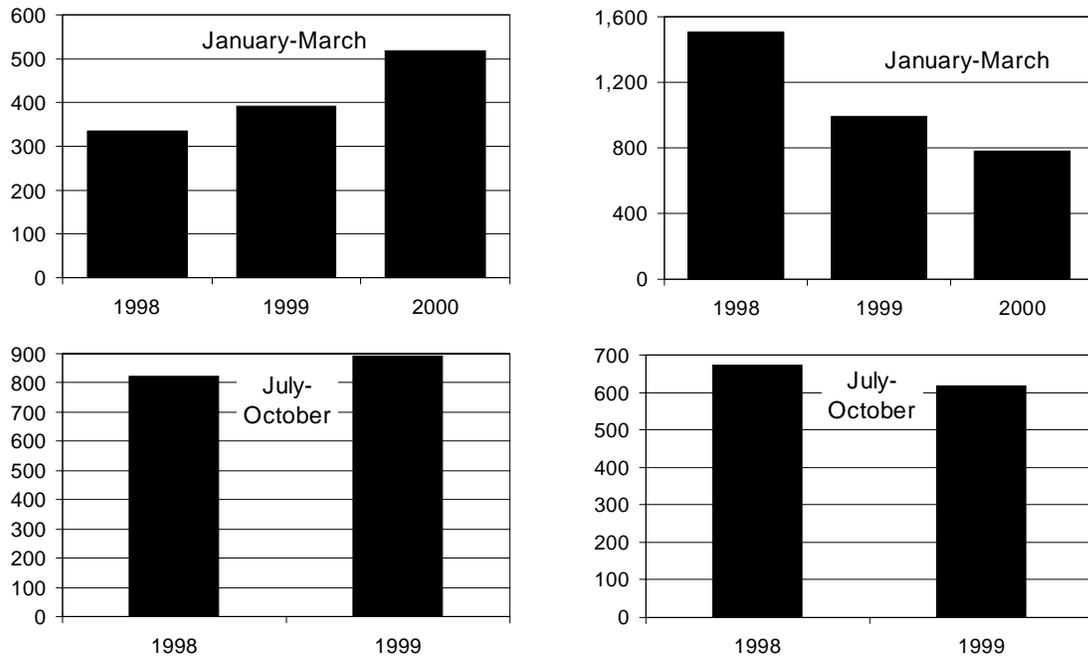


Figure 5.1. Number of 100 km² cells fished by the eastern Bering Sea pollock fishery (left panels), and average pollock catch per 100 km² cell in the eastern Bering Sea (right panels).

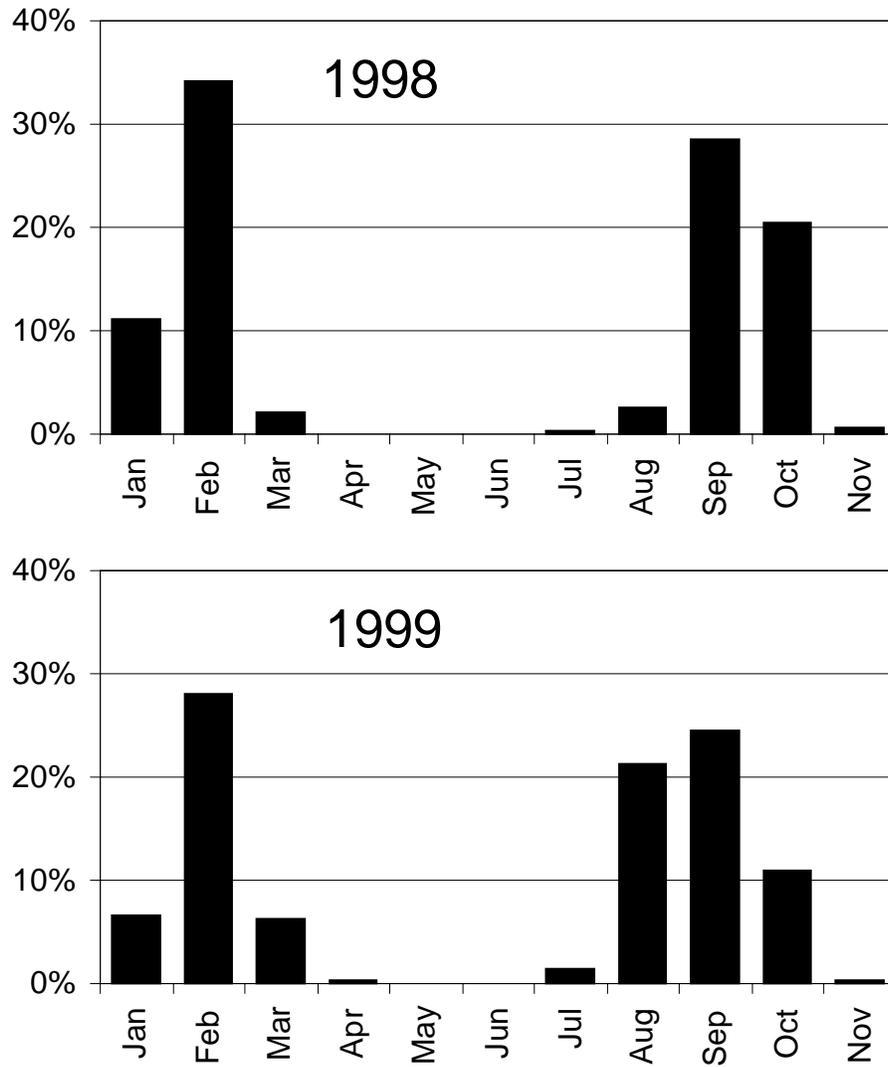


Figure 5.2. Percent of annual pollock catch in the eastern Bering Sea by month in 1998 and 1999.

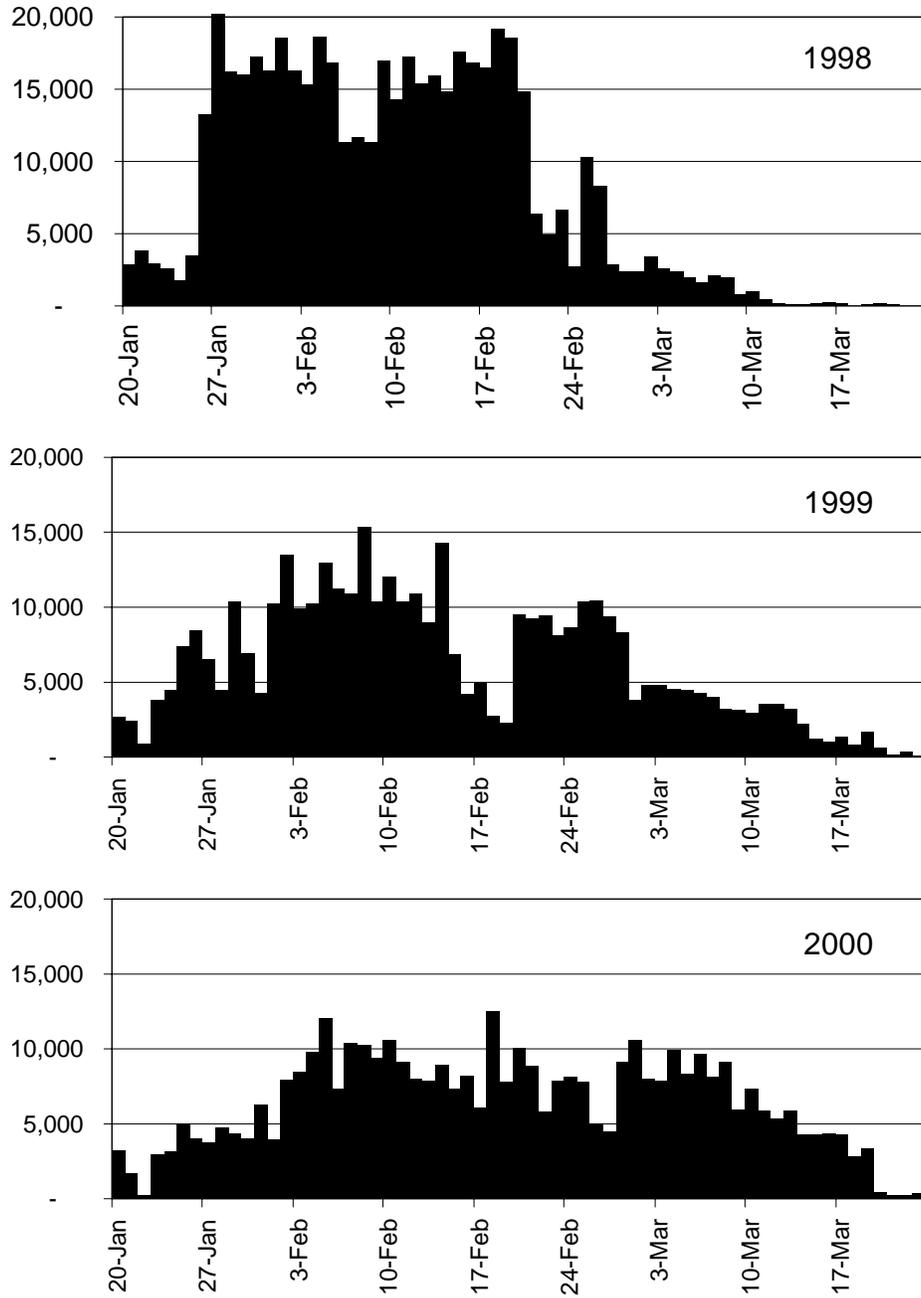


Figure 5.3. Estimated daily catch rates of pollock by the EBS pollock fishery in January-March 1998-2000.

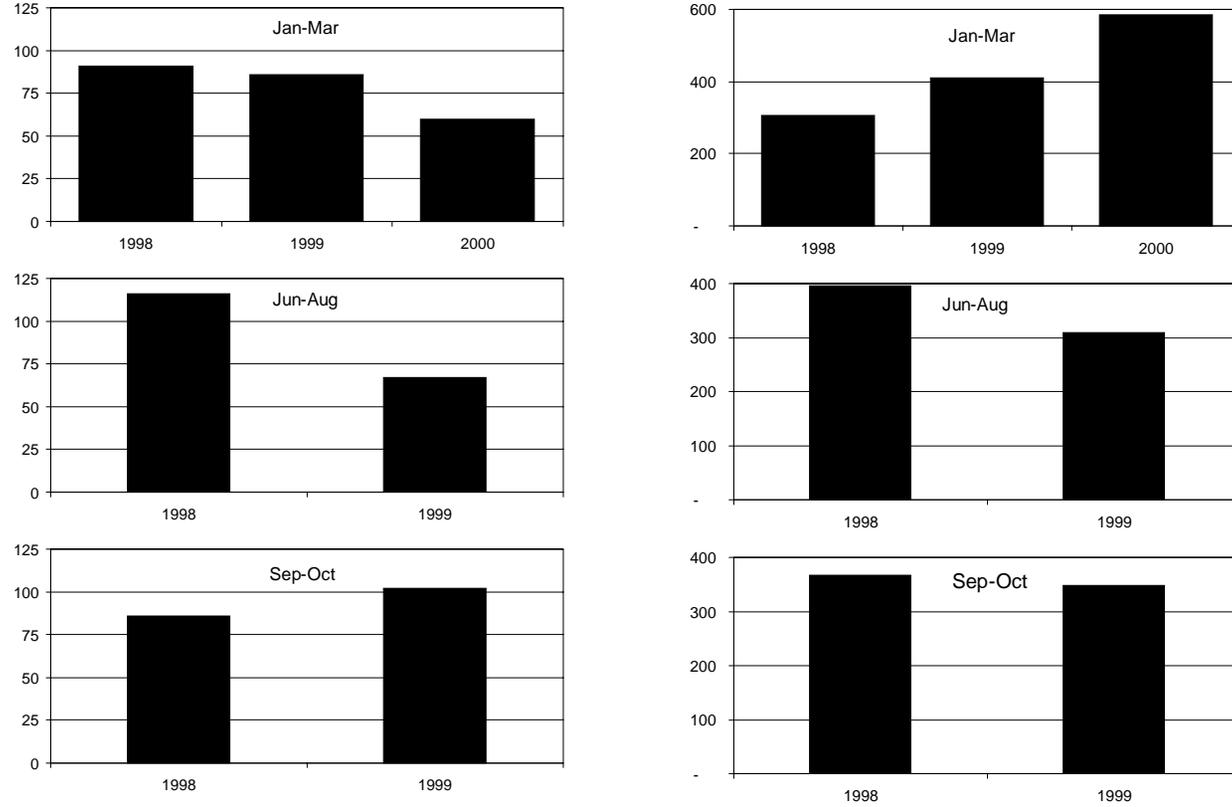


Figure 5.4. Number of 100-km² areas fished by the GOA pollock fishery from 1998 to 2000 (left panel), and average pollock catch per 100-km² area in the GOA (right panel). The data suggest that the fishery became increasingly concentrated spatially in the period from January to March, with fewer areas fished and increasing mean catch per area. The opposite trend was observed for the September and October period, with mixed results in June to August.

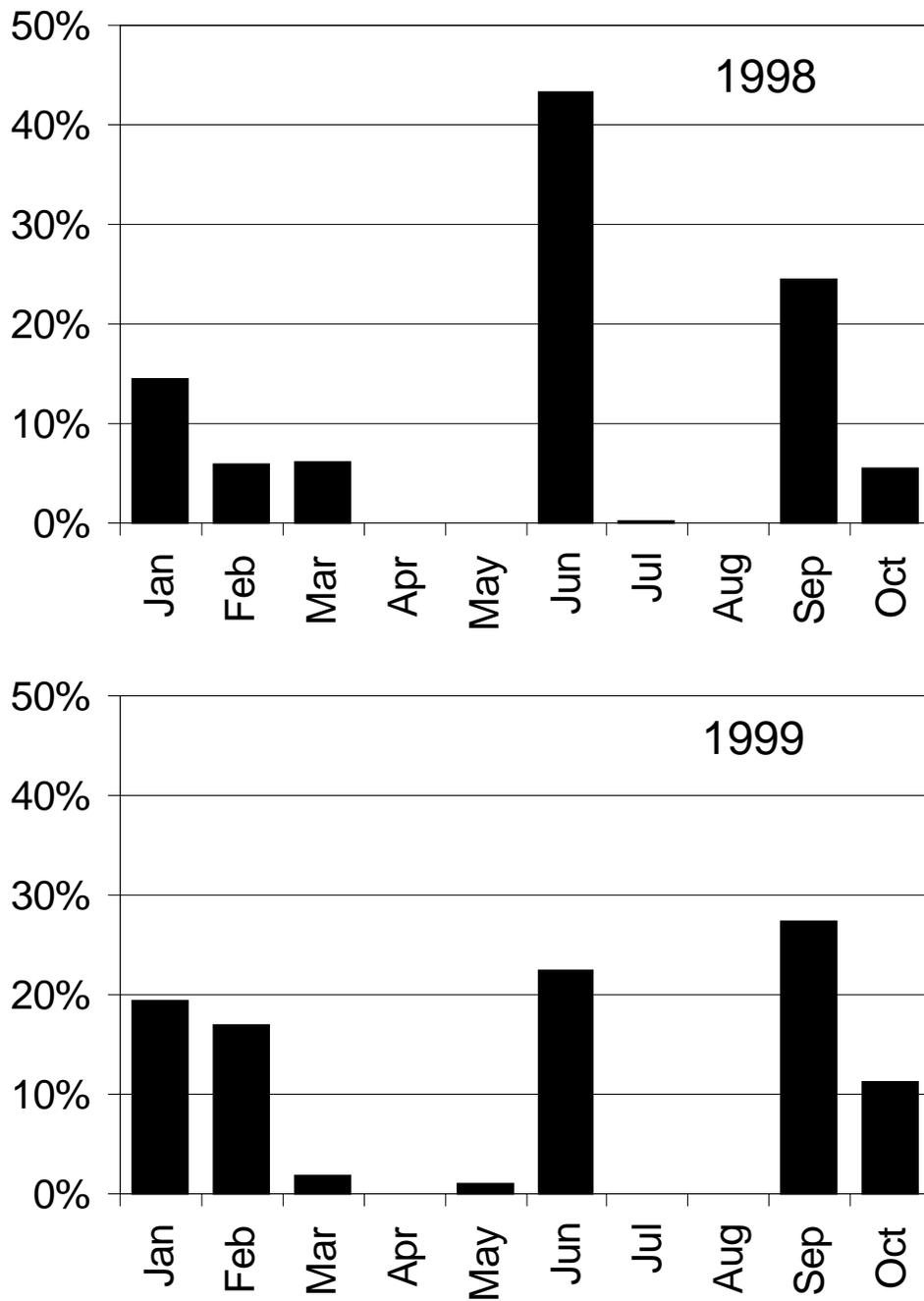


Figure 5.5. Percent of annual pollock catch caught each month in the GOA, 1998 and 1999.

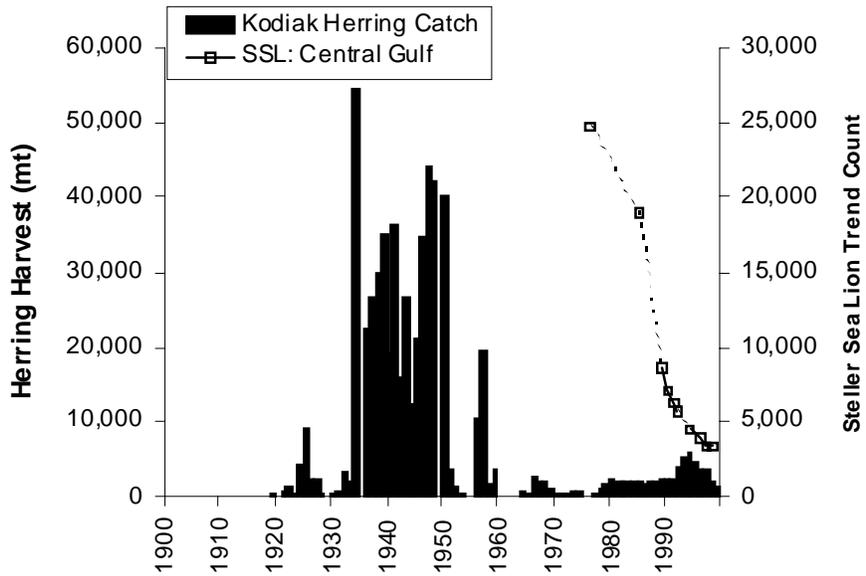
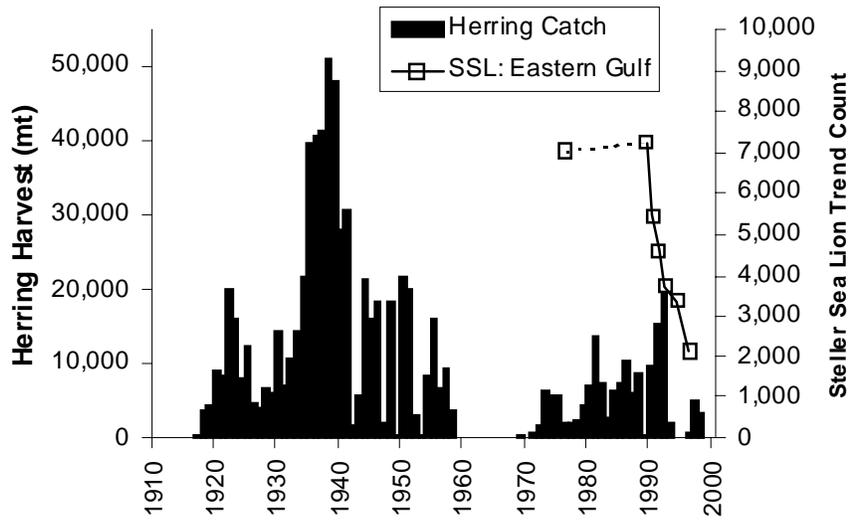


Figure 5.6. Historical harvest of herring in the central and eastern GOA and counts of Steller sea lions.

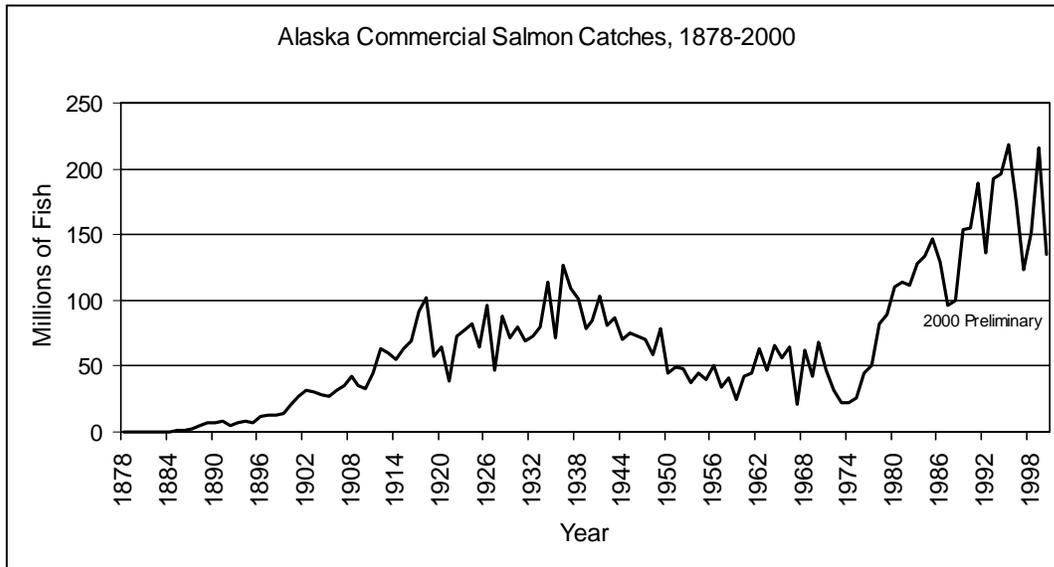


Figure 5.7. Historical salmon catches in Alaska from 1878-2000.

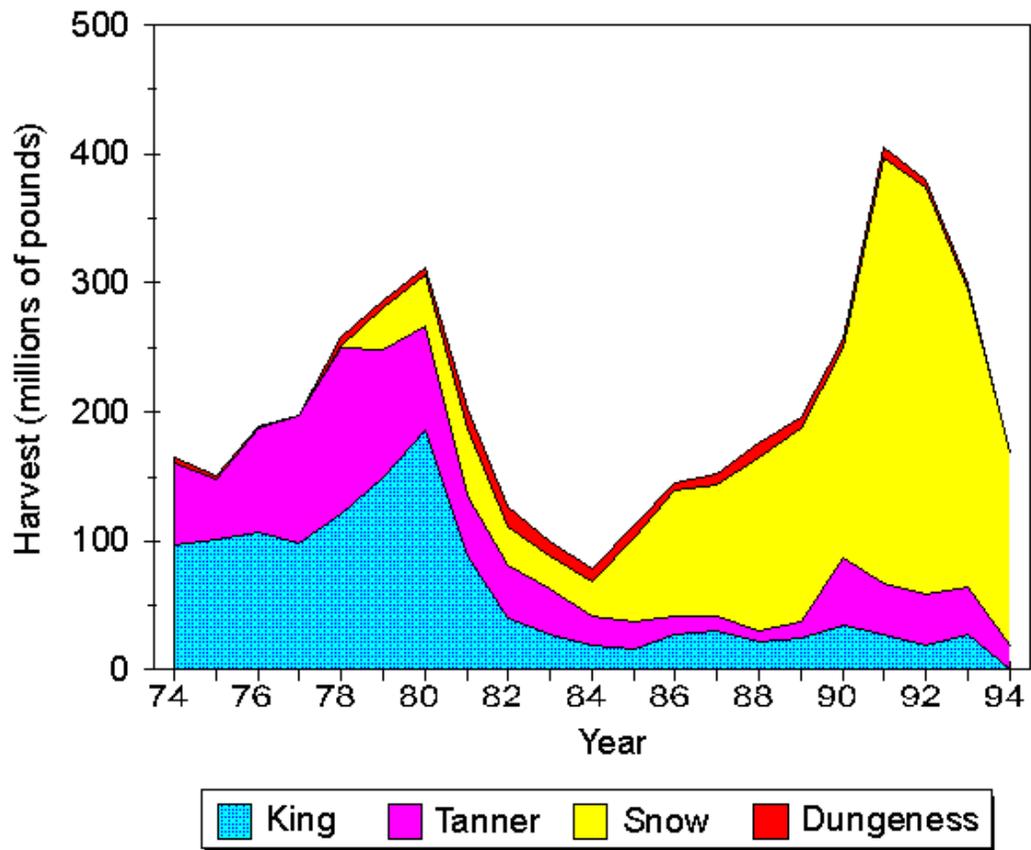


Figure 5.8. Landings of King, Tanner, snow, and Dungeness crabs in Alaska during 1974-1994. Since 1994, the catch of crab in Alaska has continued to decline due to depressed stocks.

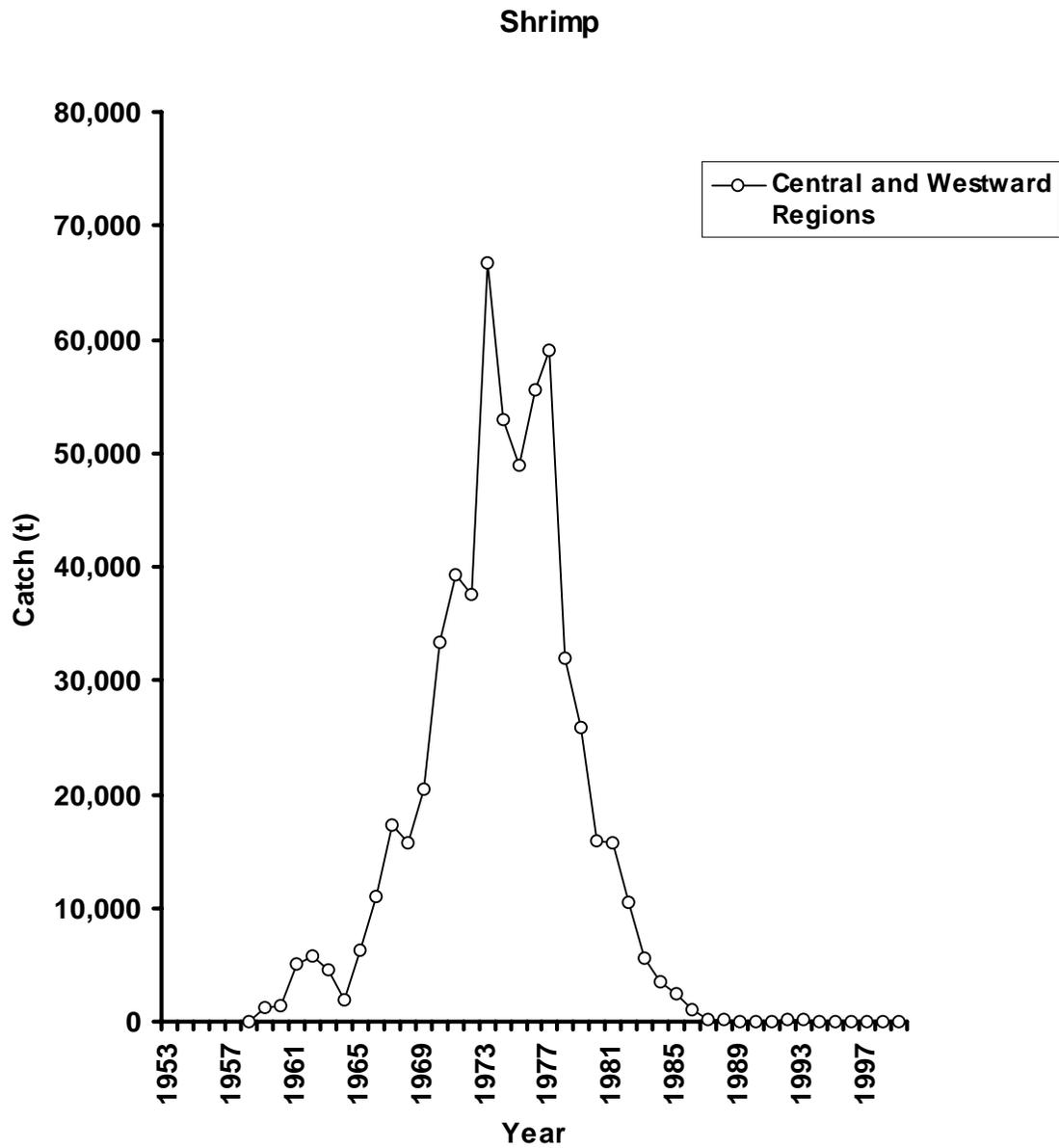


Figure 5.9. Historical annual shrimp catch (t) in the central and westward regions (west of 144° W). Landings from PWS, Cook Inlet, Kodiak, Alaska Peninsula, Chignik, Aleutian Islands, and Bering Sea contributed to the total catch.

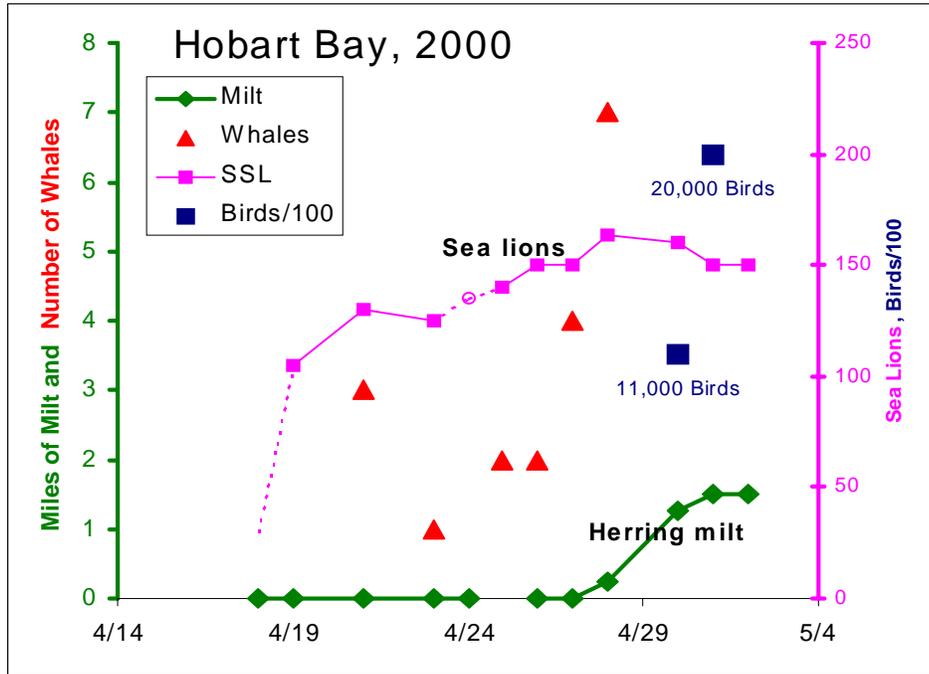


Figure 5.10. Timing of herring spawning and bird and mammal presence at Hobart Bay, southeast Alaska, in the spring of 2000.

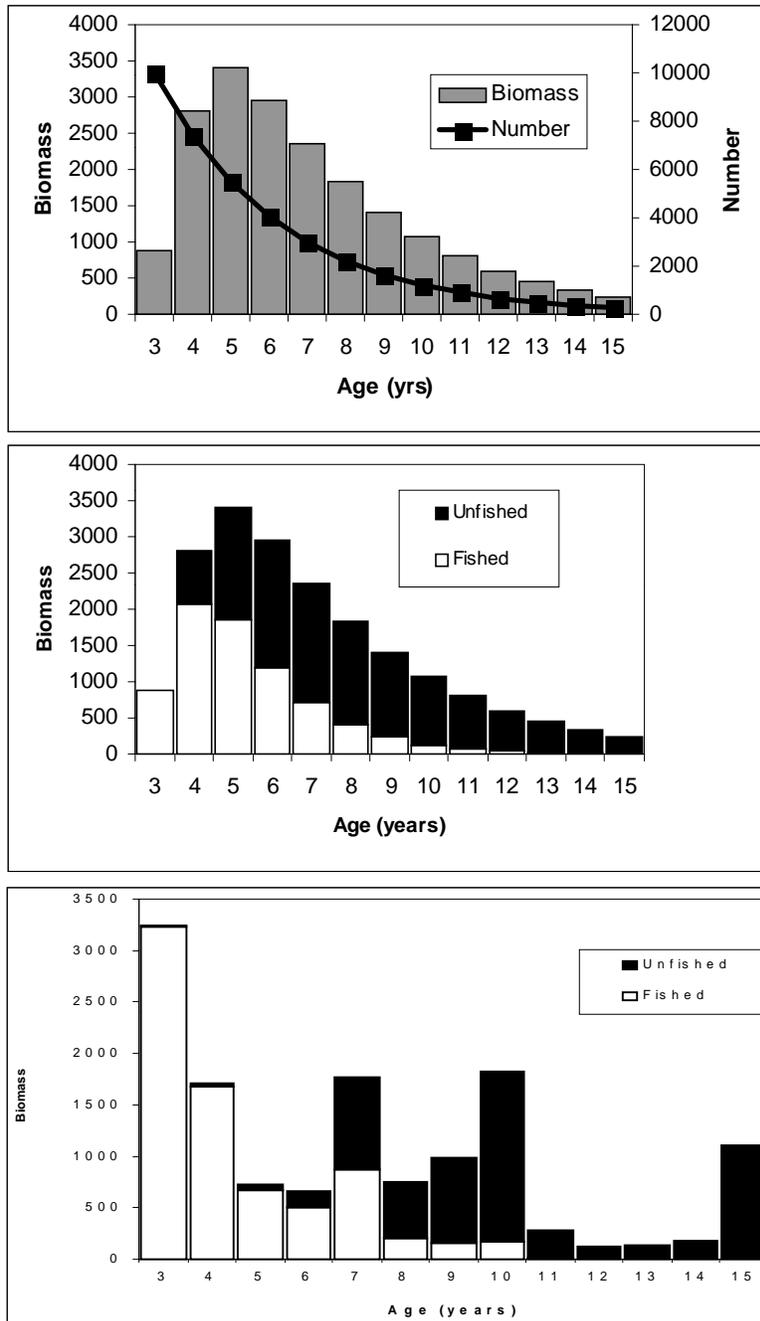


Figure 6.1. Figure 6.1a (top panel) represents a theoretical unfished population showing female spawning biomass and numbers at age from age 3. Figure 6.1b (middle panel), shows a theoretical female spawning stock biomass by age in a population fished at $F_{40\%}$ (white portion of each bar) and in an unfished population (black and white portions combined). Figure 6.1c (bottom panel) illustrates the biomass at age for the eastern Bering Sea pollock stock in 1999. Again, the white portion of each bar indicates the biomass available in the fished portion of the population, and the black portion represents the portion that was removed in previous years and would have been available if the stock had not been fished.

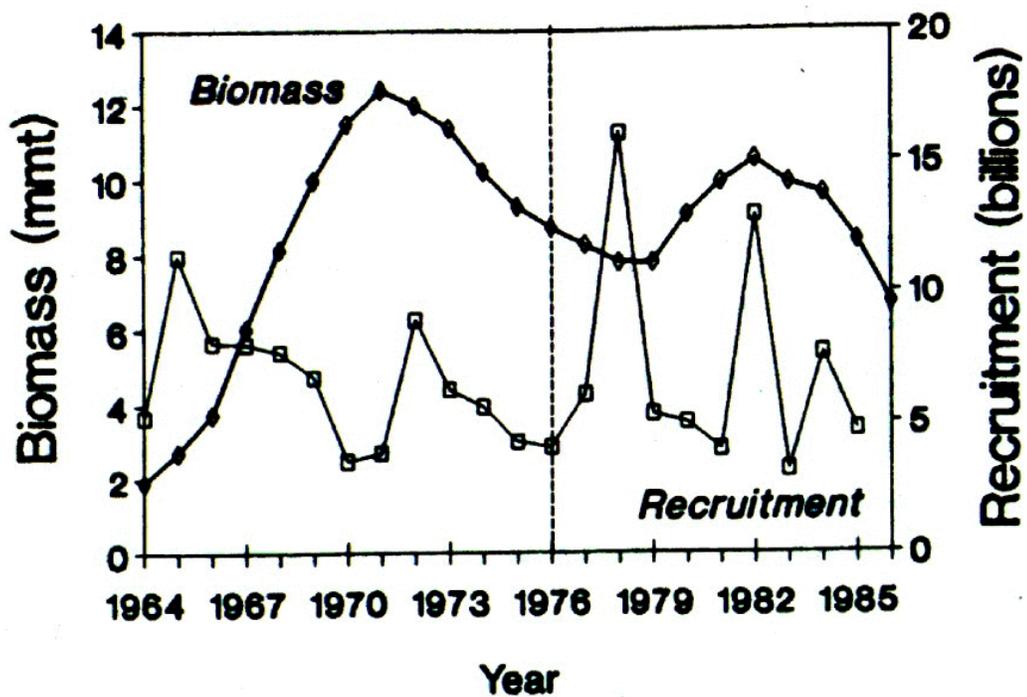
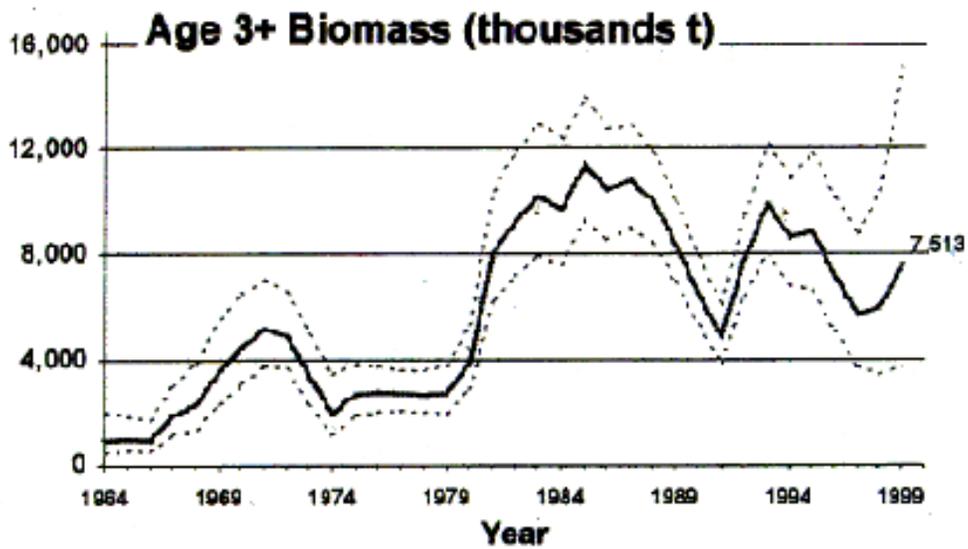


Figure 6.2. (6.2a Top) Estimated biomass of eastern Bering Sea pollock (age 3+) as described in Ianelli et. al. (1999). (6.2b Bottom) Estimated biomass of eastern Bering Sea pollock (age 3+) for the period from 1964-1985 as presented in Megrey and Wespestad, 1990.

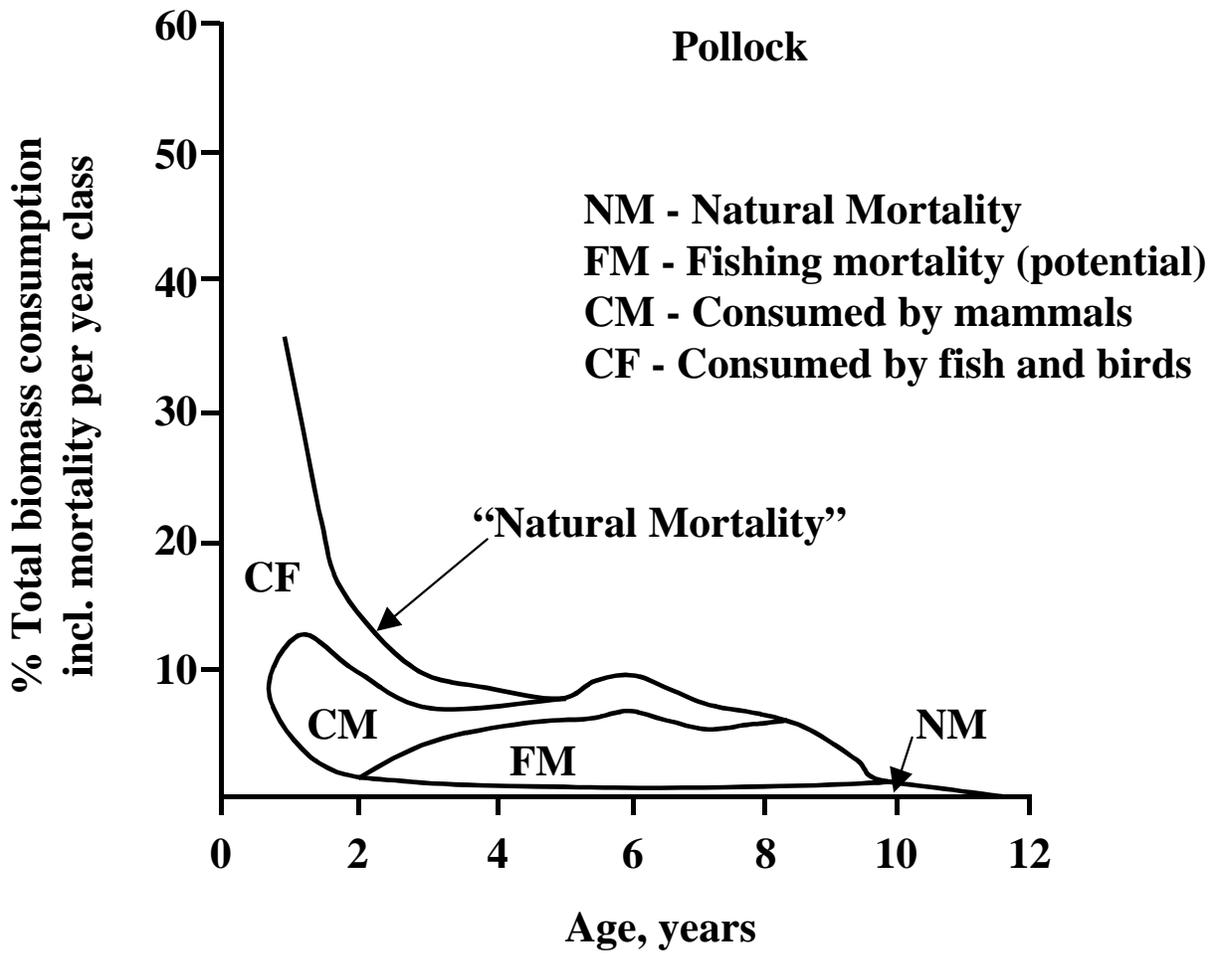


Figure 6.3. Distribution of “consumption” with age of walleye pollock, as percent of total biomass. (From BSAI FMP, p. 179.)

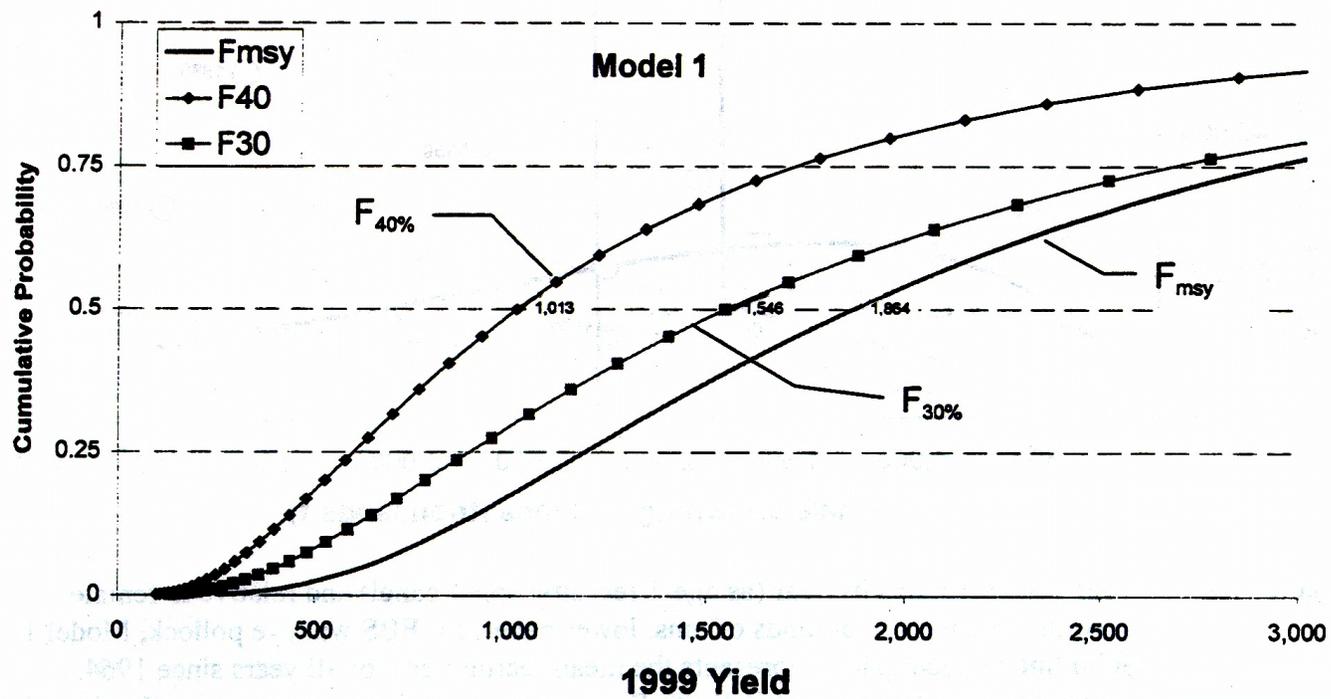


Figure 6.4. Measures of uncertainty in 1999 (unadjusted) yield for EBS pollock as a cumulative distribution. Values along the curve represent the estimated probability (vertical axis) that the 1999 yield will be lower than the corresponding value on the horizontal axis (reprinted from Ianelli et. al., 1998).

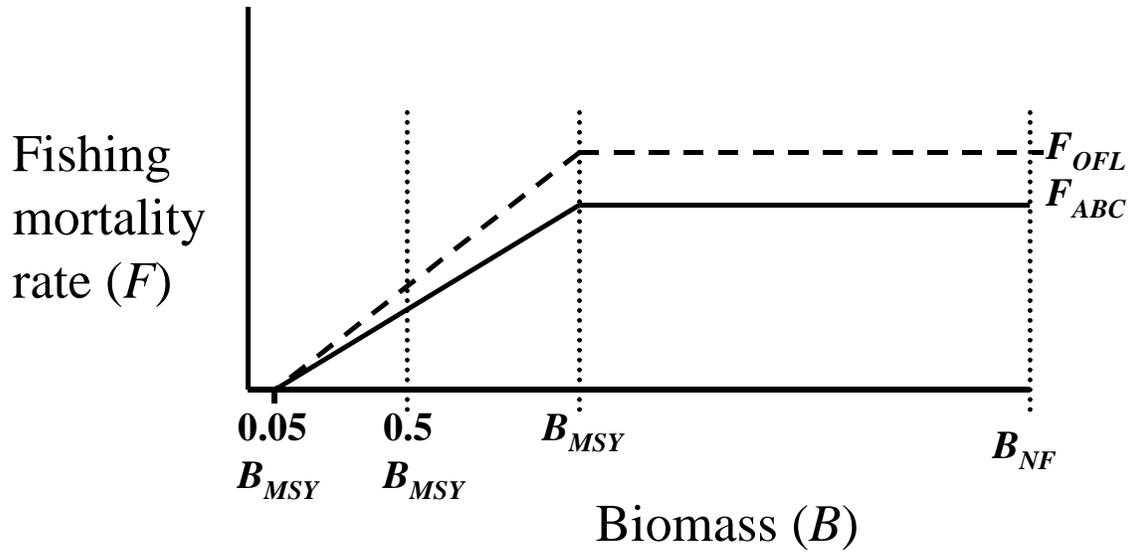
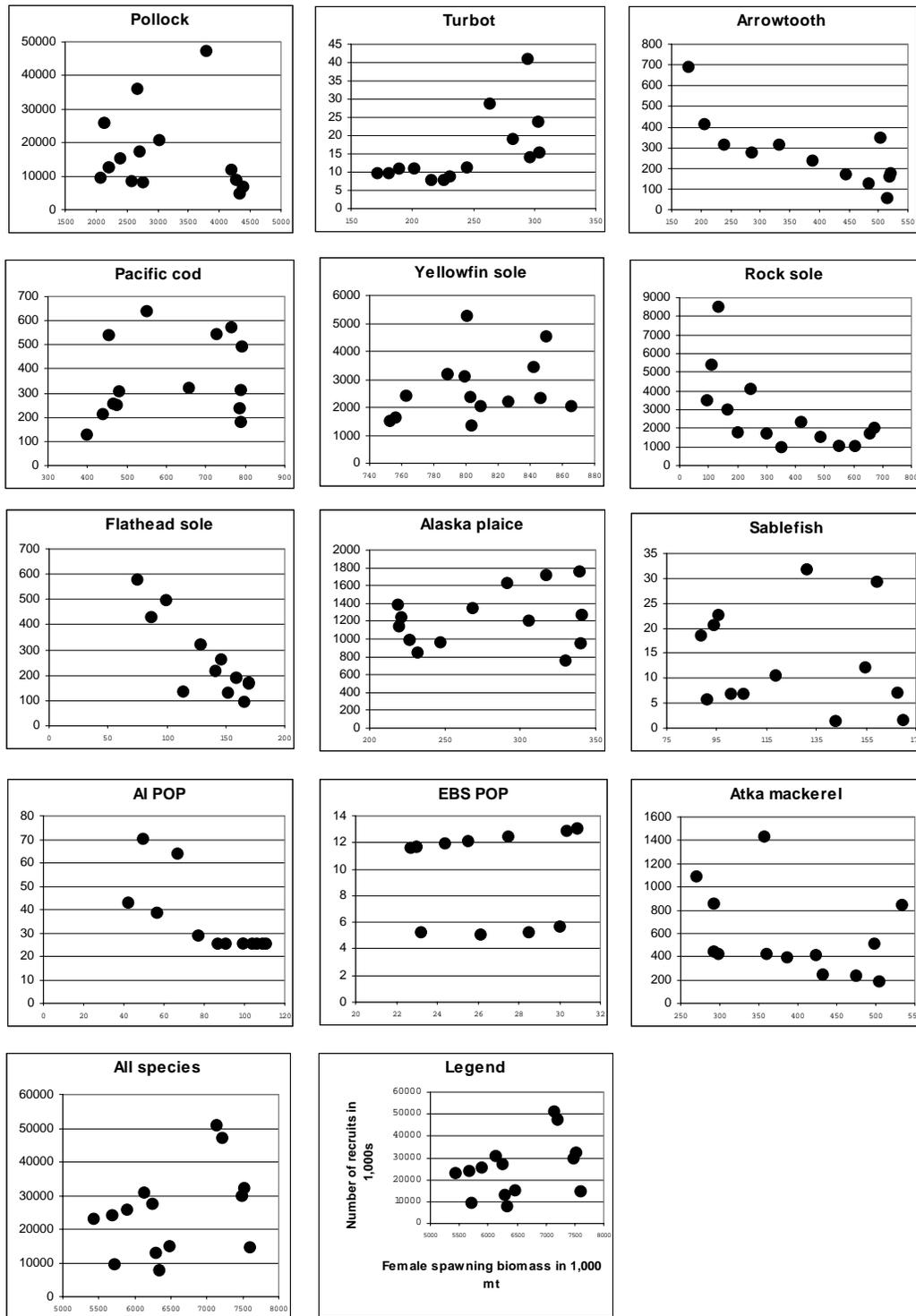
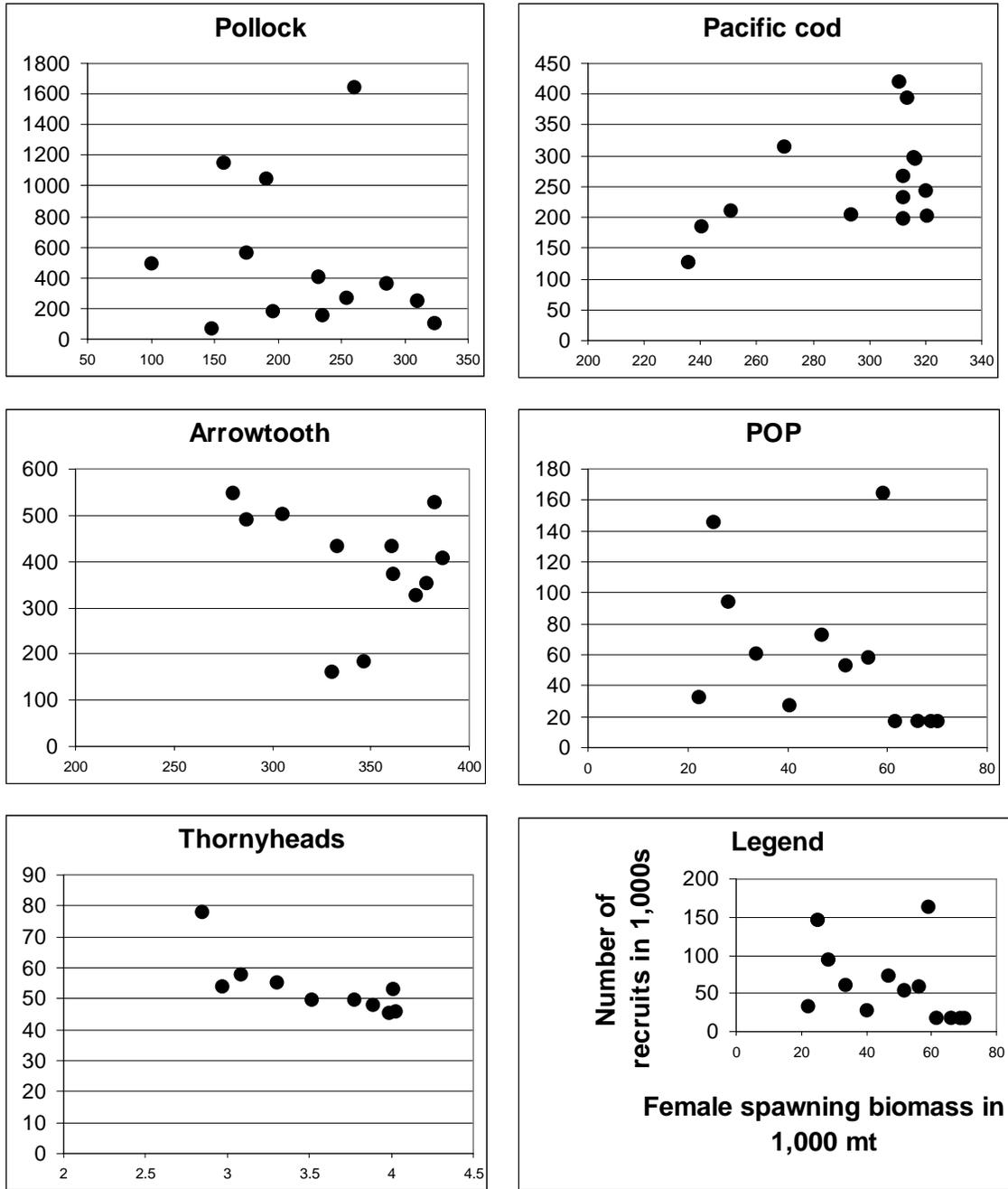


Figure 6.5. Theoretical framework for setting fishery mortality rates to achieve ABC (and avoid OFL) based on stock biomass as determined relative to the estimated size of the stock if it had not been fished (B_{NF}).

Number of Recruits (1,000s)



Number of Recruits (1,000s)



Female Spawning Biomass (1,000s)

Figure 6.7. Number of recruits as a function of female spawning biomass in the GOA, 1985-1999.

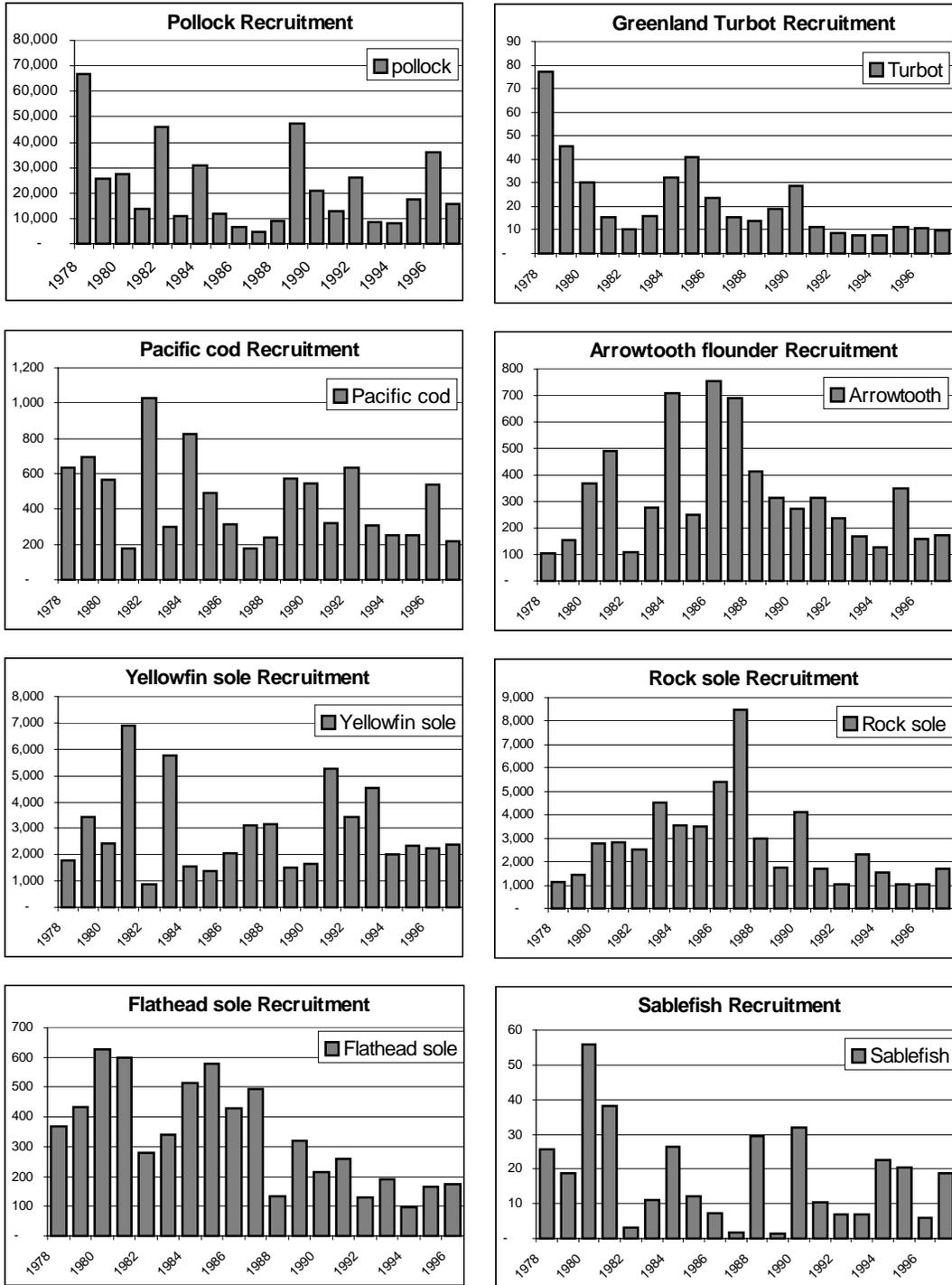


Figure 6.8. Number of recruits (by 1,000) of each species in the BSAI (age of recruitment to the fishery varies by species).

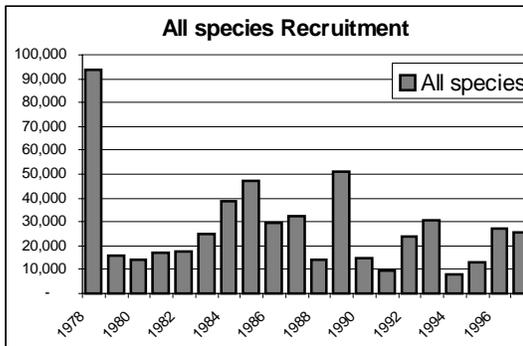
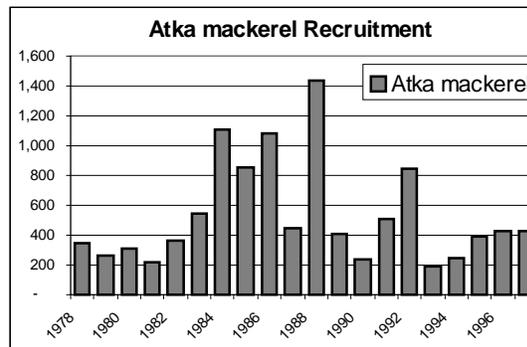
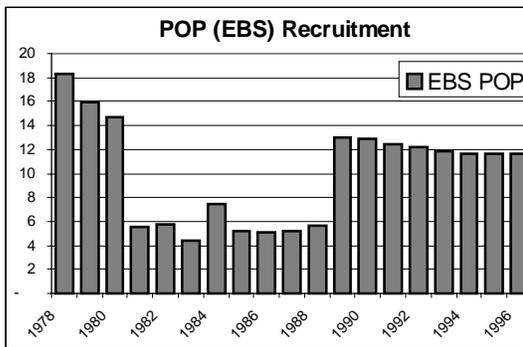
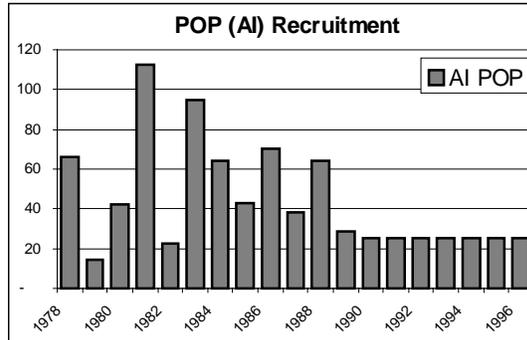
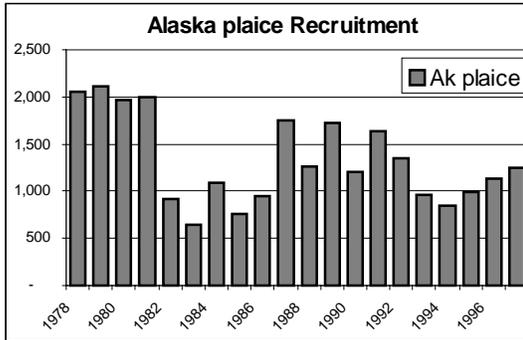


Figure 6.8. Continued.

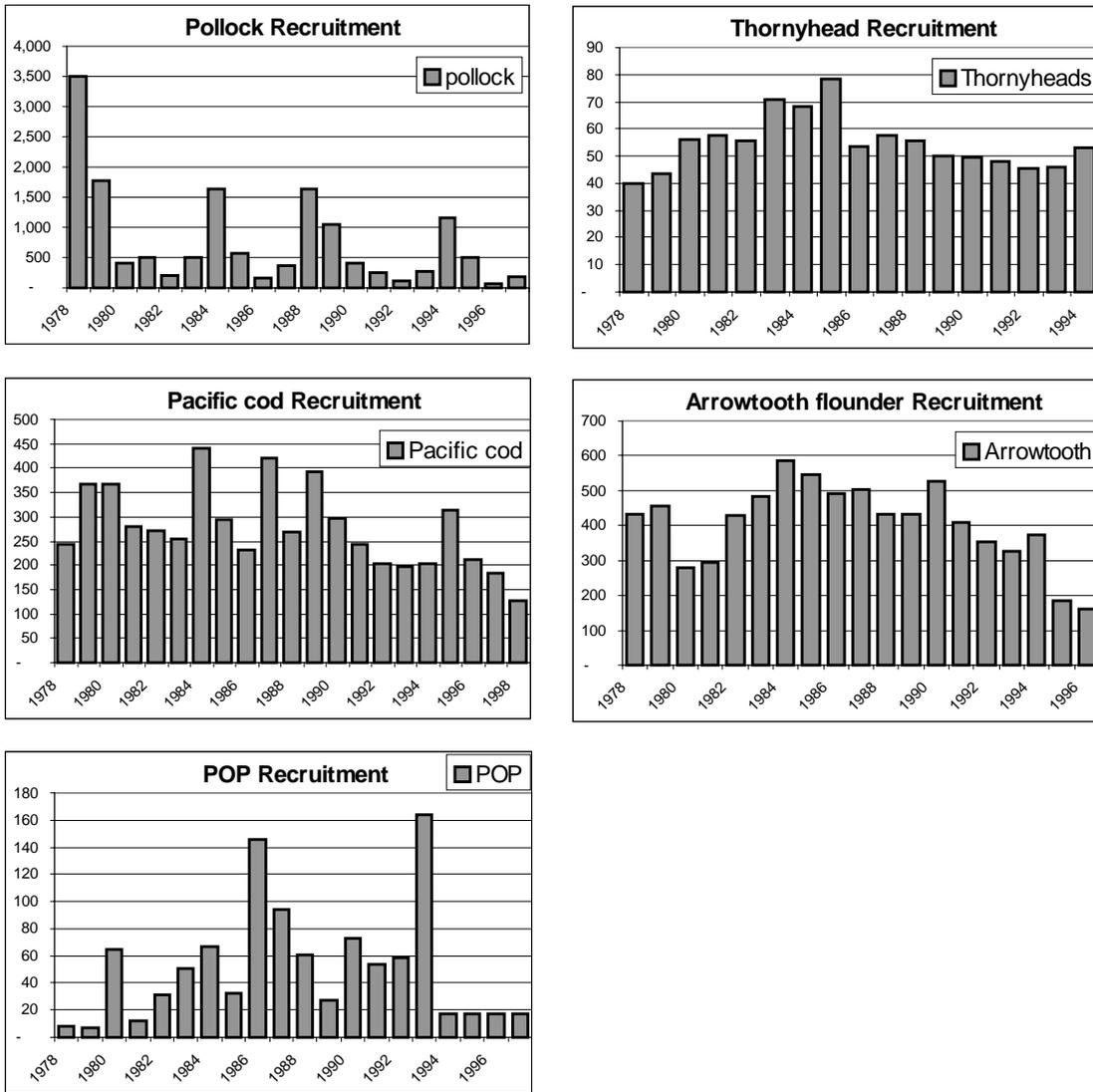


Figure 6.9. Number of recruits (by 1,000) of each species in the GOA (age of recruitment to the fishery varies by species).

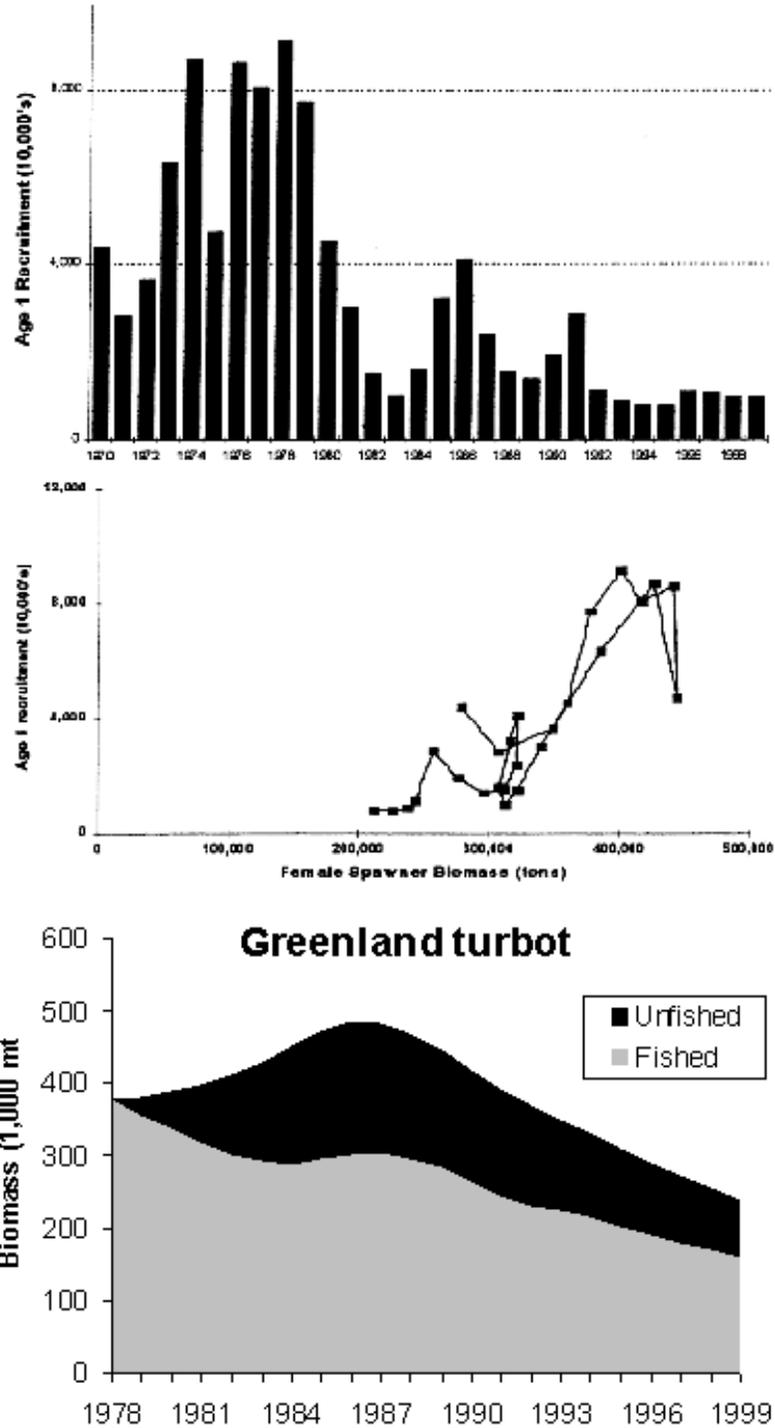


Figure 6.10. Estimated recruitment to age 1 (6.10a upper panel) and the observed stock-recruitment pattern (6.10b middle panel) of Greenland turbot in the EBS/AI region, 1970-1999 (reprinted from Ianelli et. al., 1999; their Figure 4.9), and estimated Greenland turbot biomass at fished and theoretical unfished levels (6.10c bottom panel).

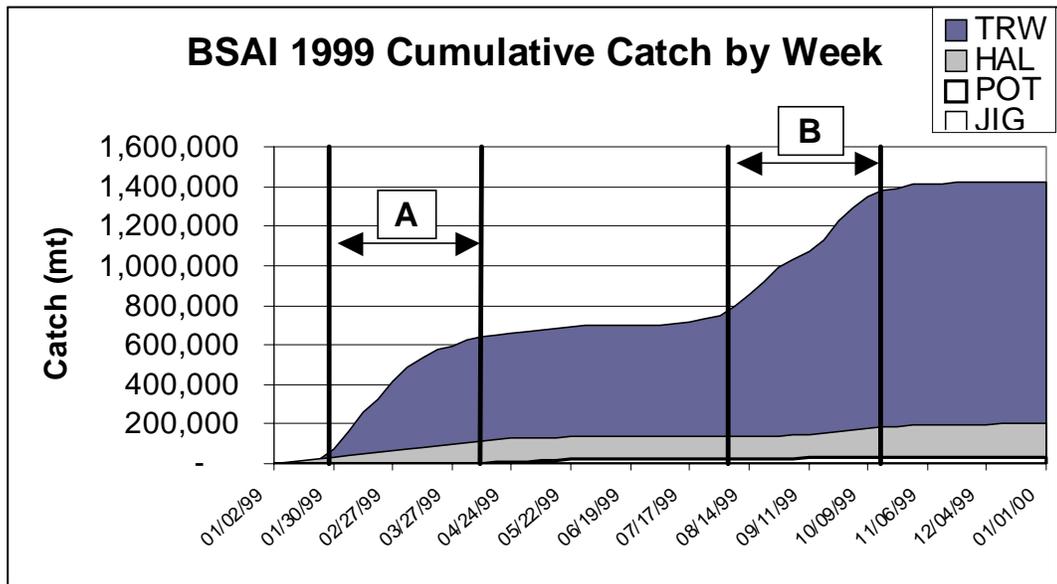
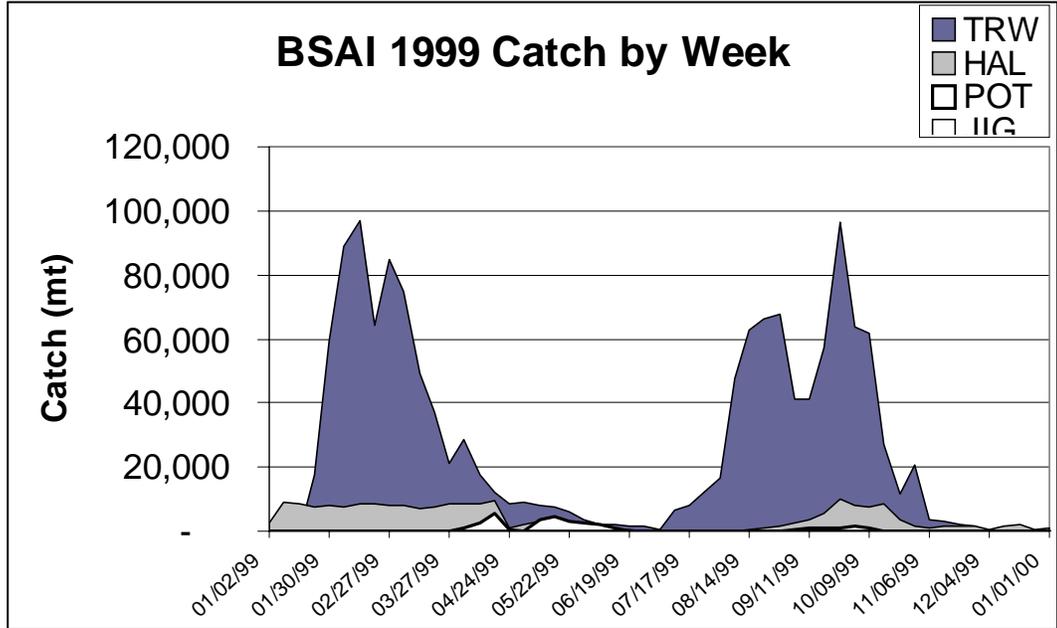


Figure 6.11. Figure 6.11a (top panel) displays the weekly catch rates in the BSAI by gear type for all groundfish species. Figure 6.11b (bottom panel) displays the cumulative catch by week. This figure reveals the two time periods (A and B) in which the majority of groundfish are harvested.

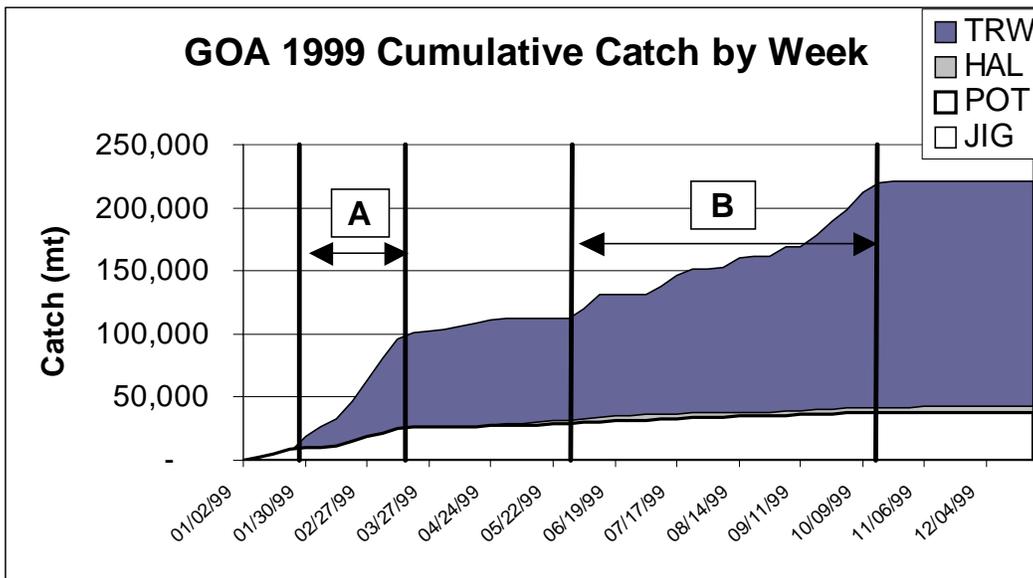
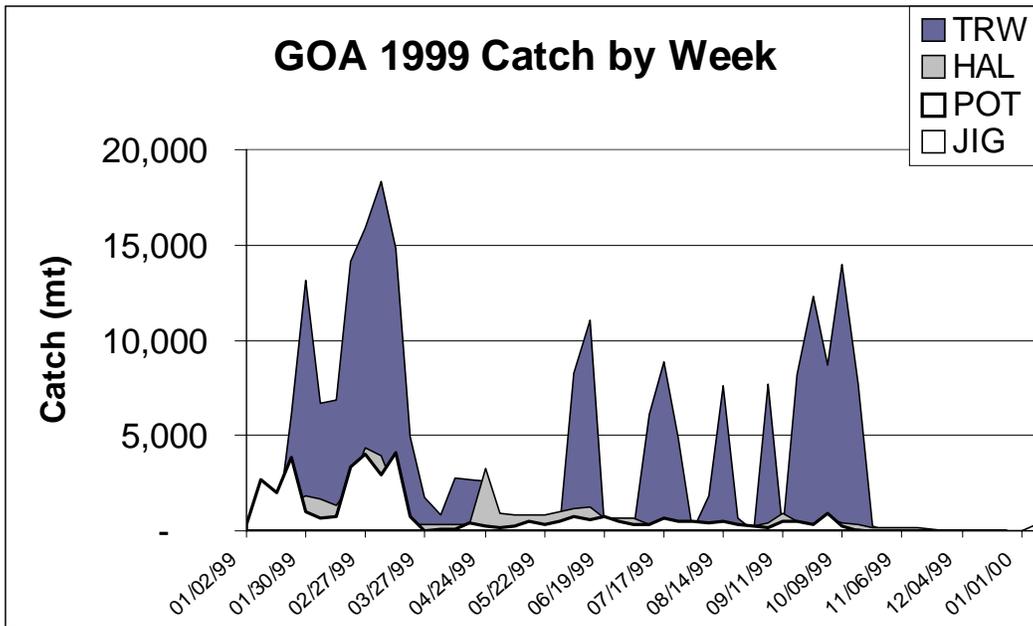


Figure 6.12. Figure 6.12a (top panel) displays the weekly catch rates in the GOA by gear type for all groundfish species. Figure 6.12b (bottom panel) displays the cumulative catch by week. This figure reveals the two time periods (A and B) in which the majority of groundfish are harvested.

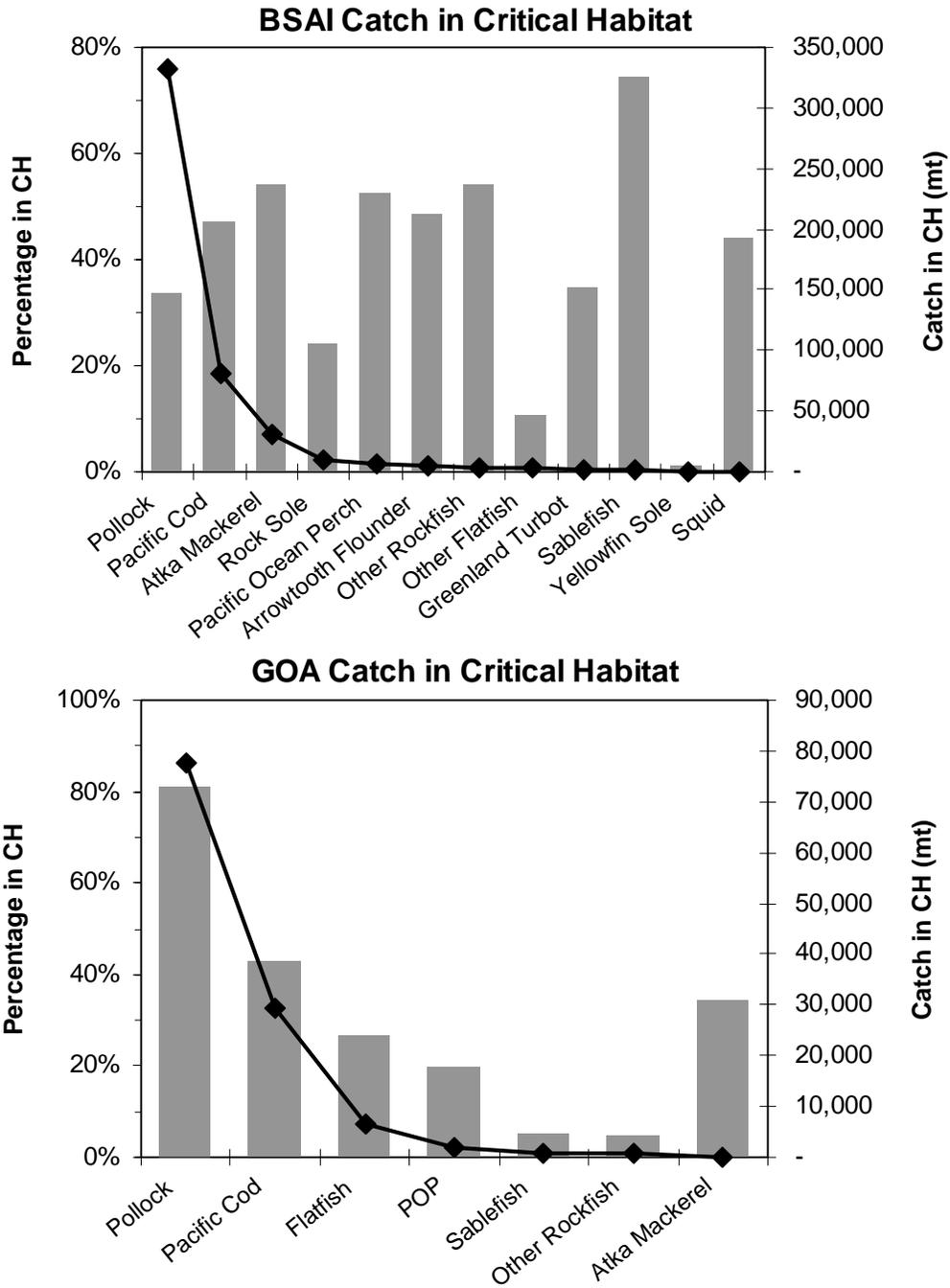


Figure 6.13. BSAI (top panel) and GOA (bottom panel) catch in critical habitat in percent (bars, left Y axis) and amount (line graph in mt, right Y axis).

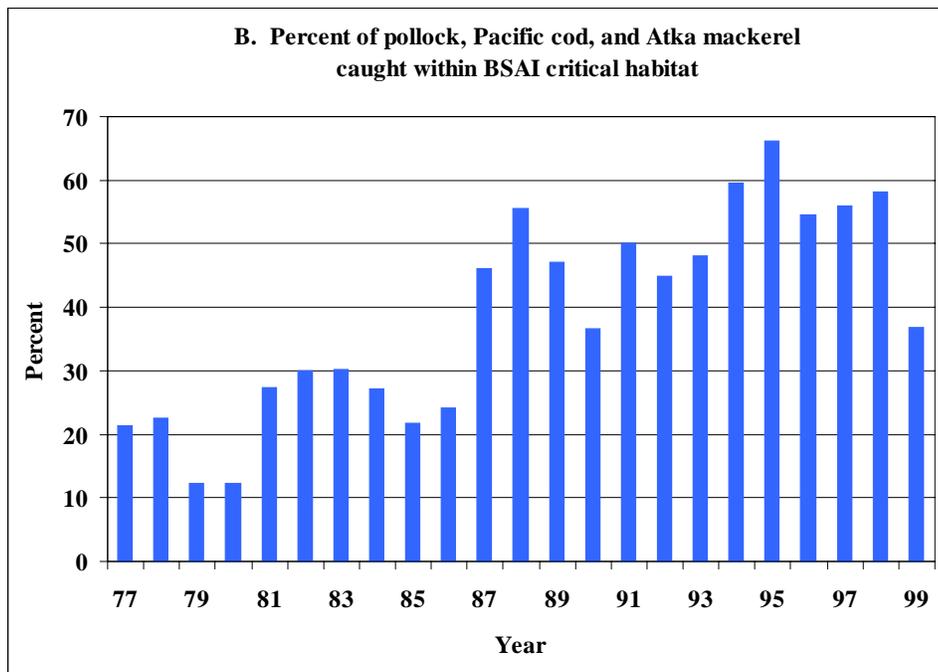
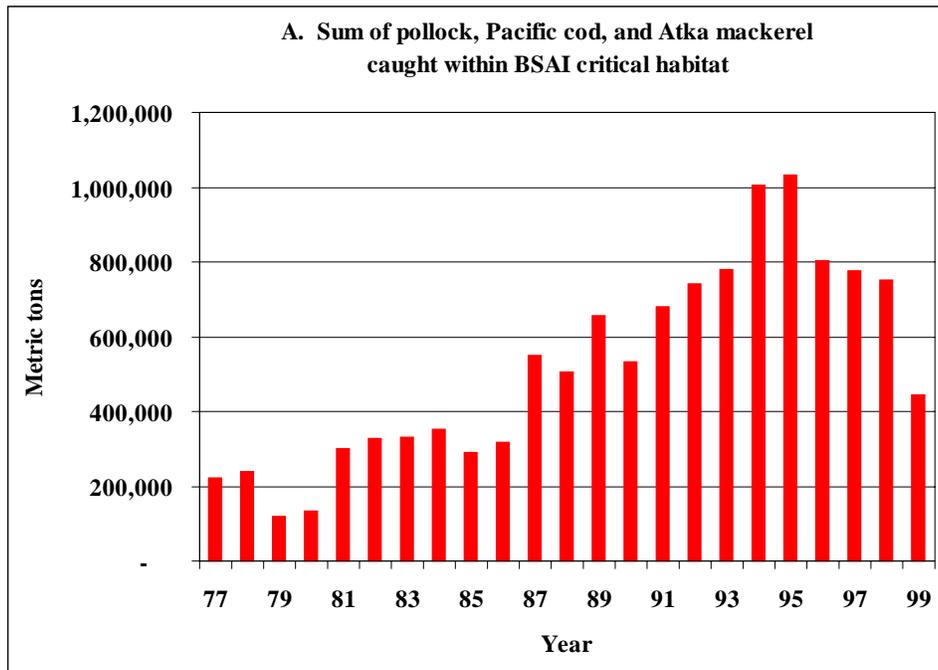


Figure 6.14a. Total catch of pollock, Pacific cod, and Atka mackerel in critical habitat (top panel, in mt) and as a percent of the annual catch (bottom panel) for the BSAI and GOA.

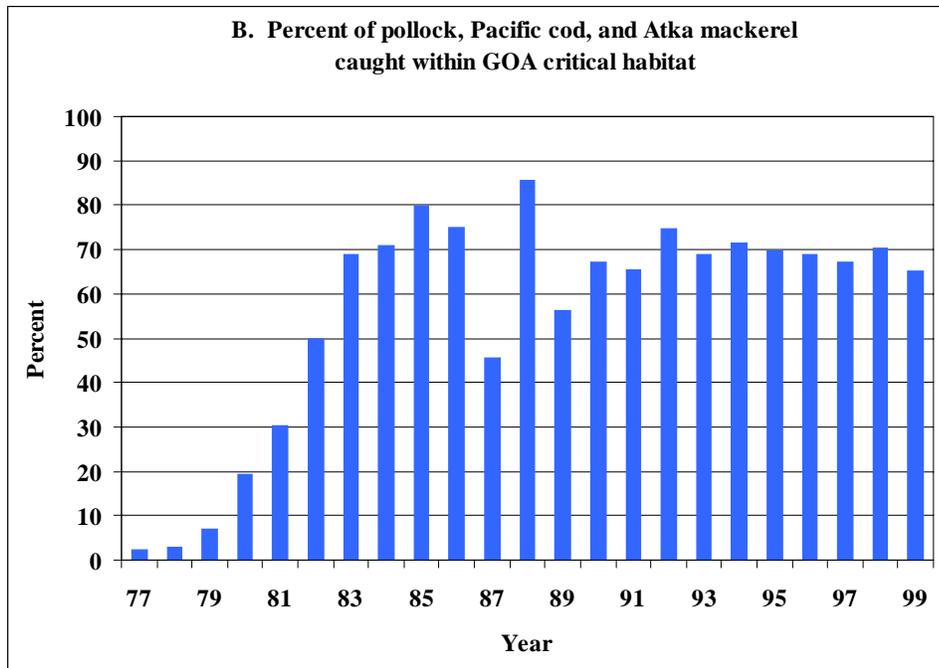
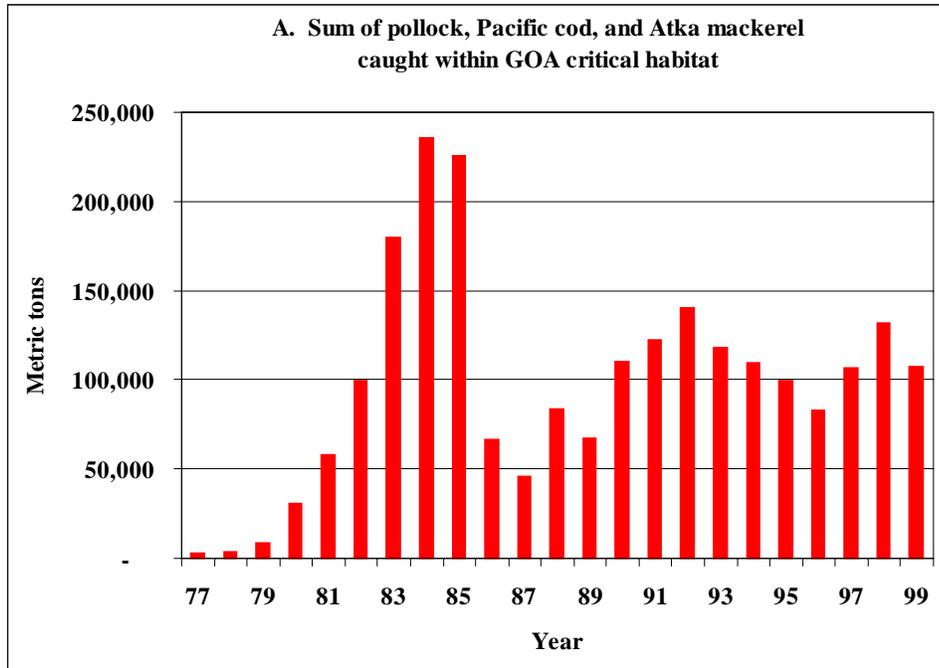


Figure 6.14b. Total catch of pollock, Pacific cod, and Atka mackerel in critical habitat (top panel, in mt) and as a percent of the annual catch (bottom panel) for the BSAI and GOA.

Figure 6.15a. Weekly catch rates of Atka mackerel, Pacific cod, pollock, and all other groundfish species in the BSAI from 1995-1999, both inside and outside of critical habitat.

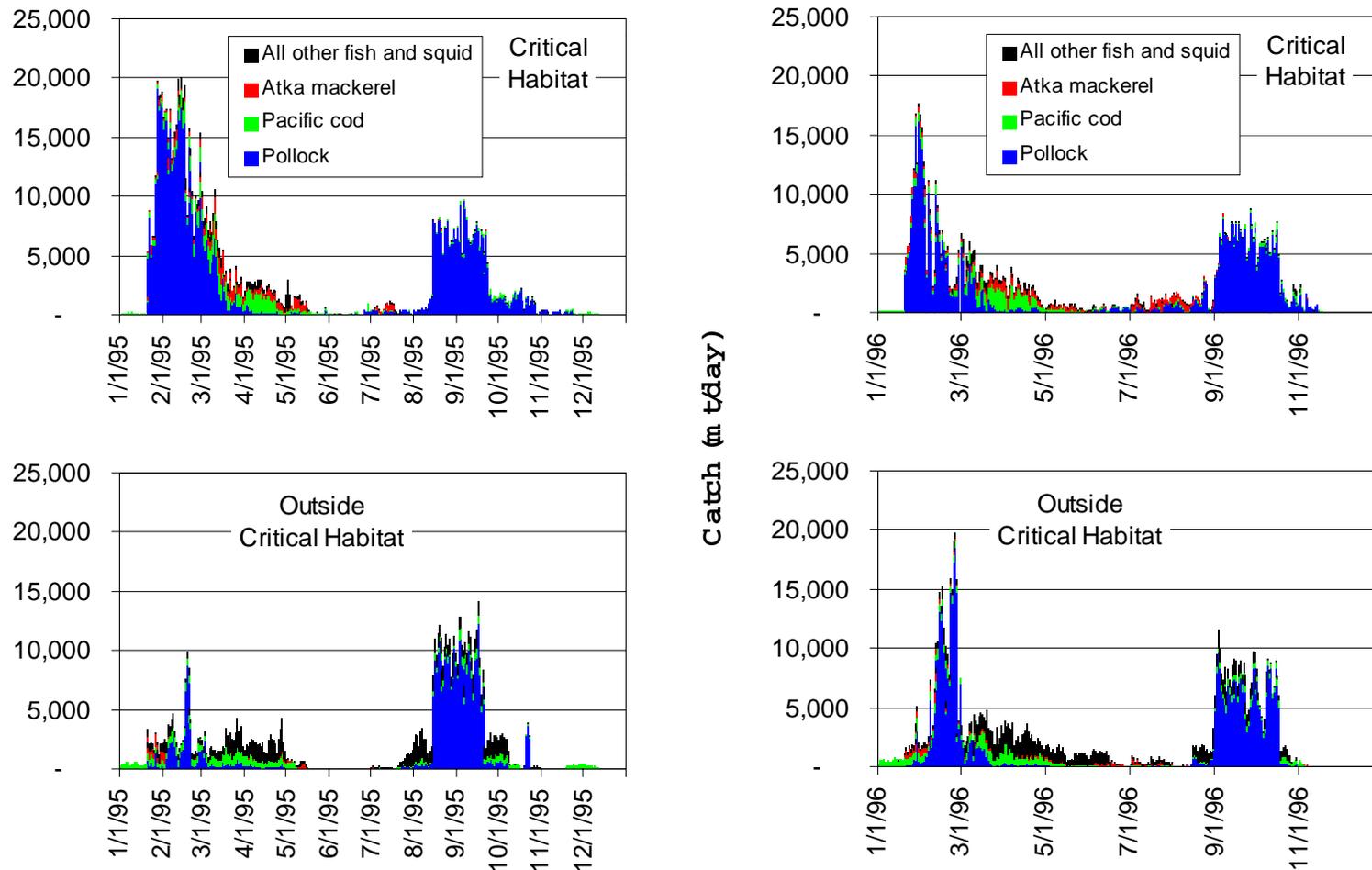


Figure 6.15a. BSAI continued.

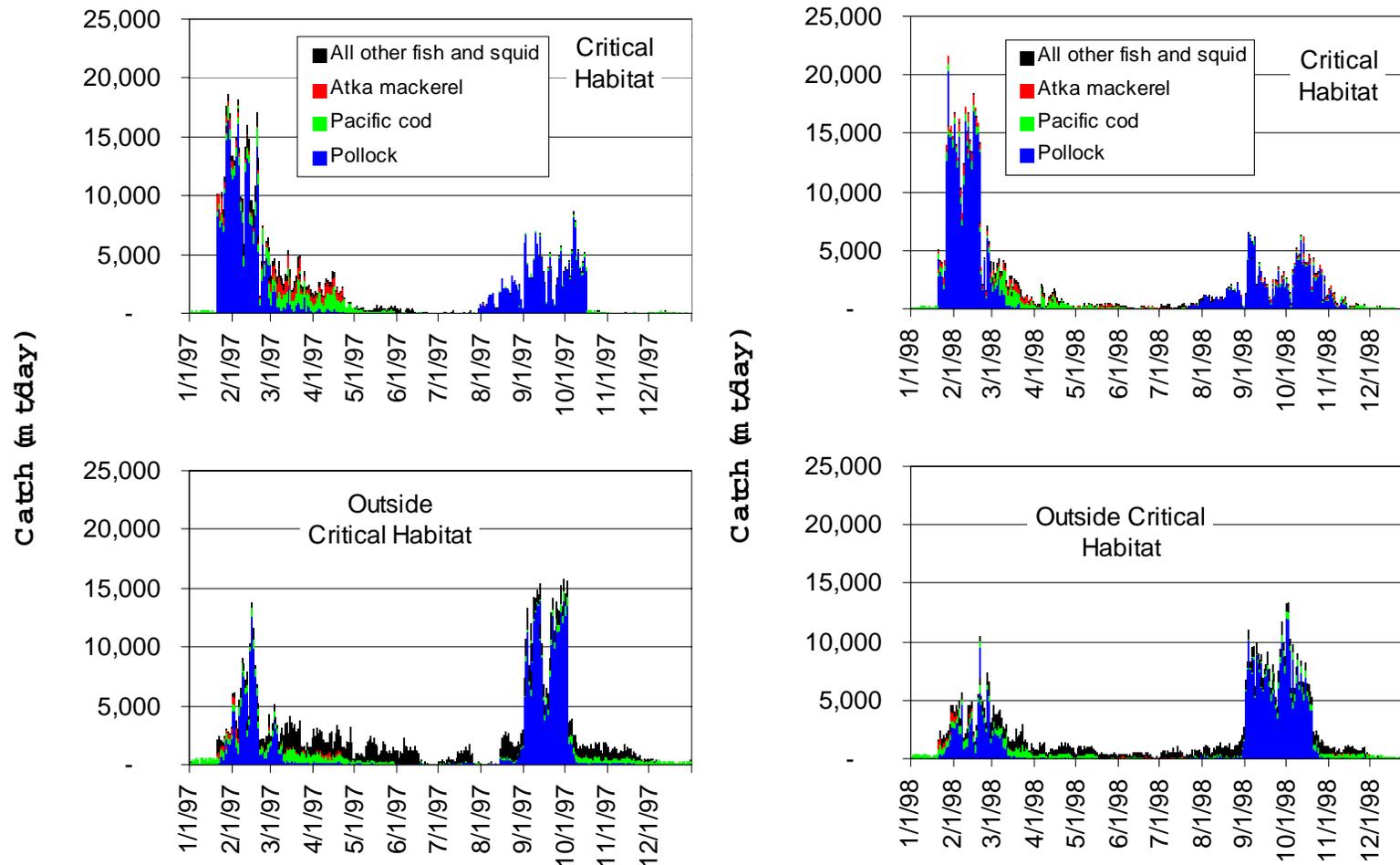


Figure 6.15a. BSAI continued.

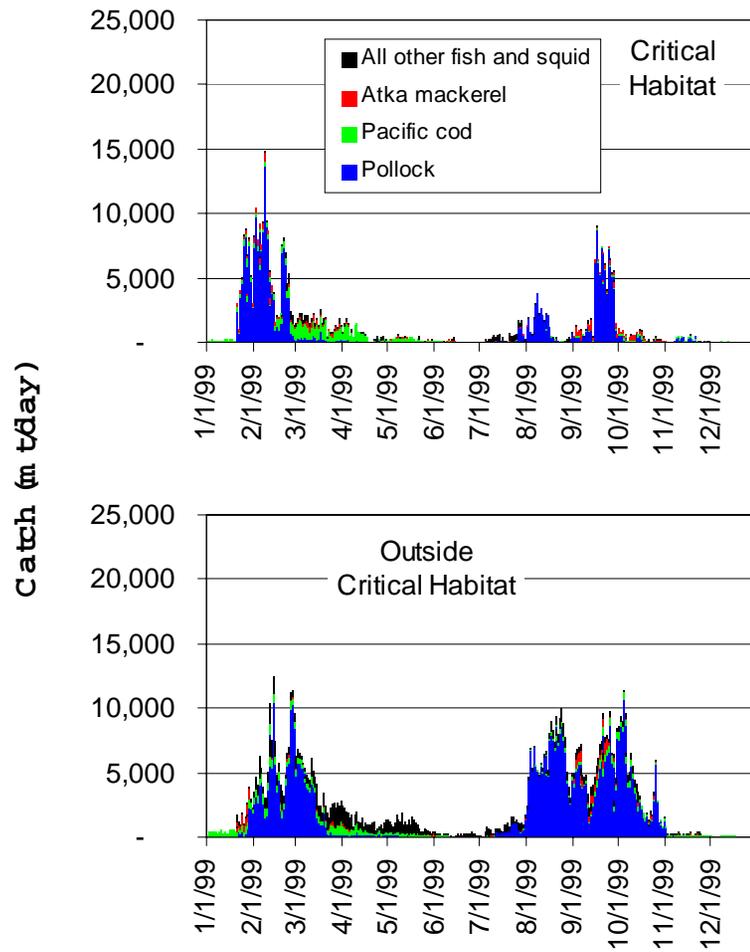


Figure 6.15b. Weekly catch rates of Pacific cod, pollock, and all other groundfish species in the GOA from 1995-1999, both inside and outside of critical habitat.

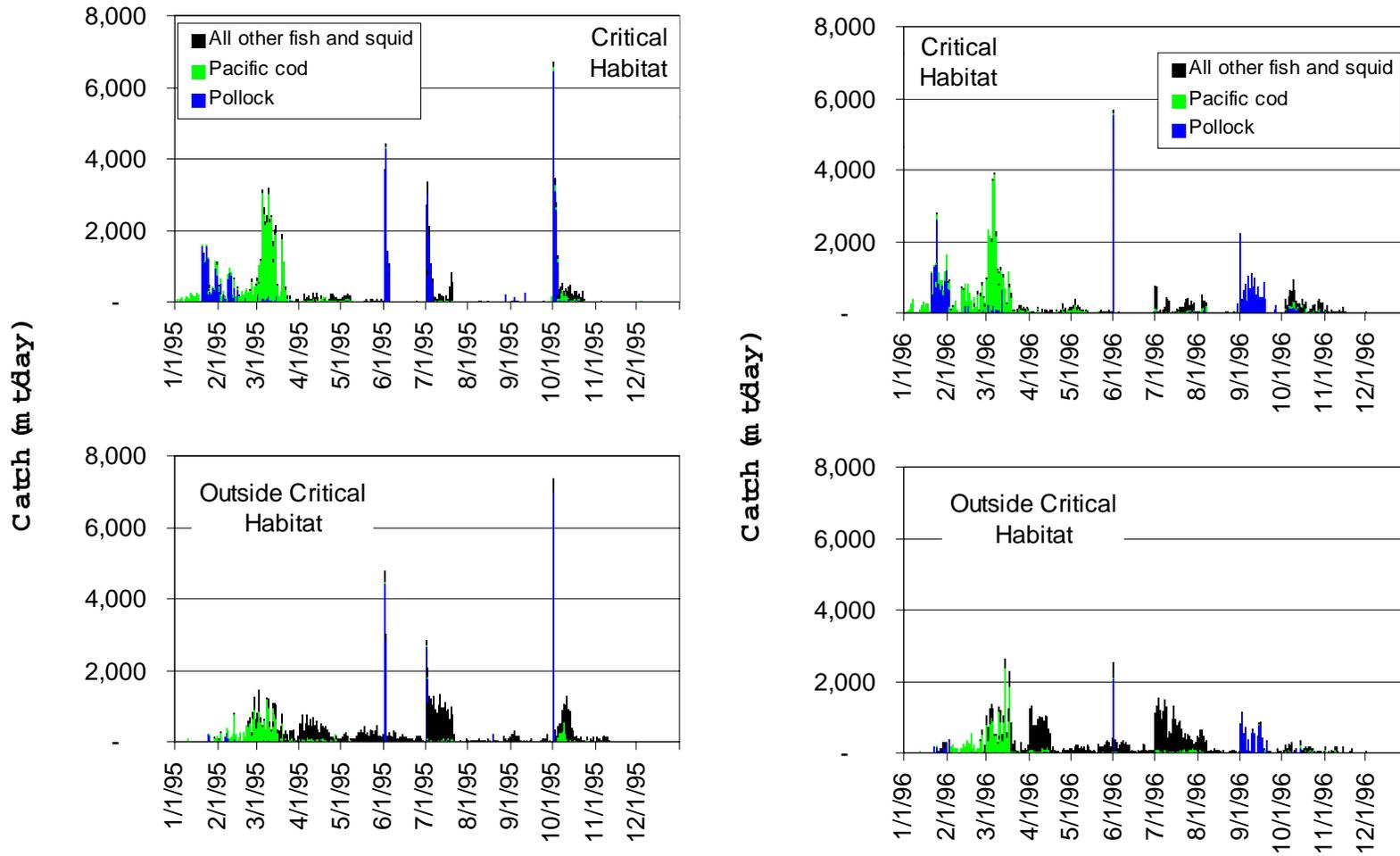


Figure 6.15b. GOA continued.

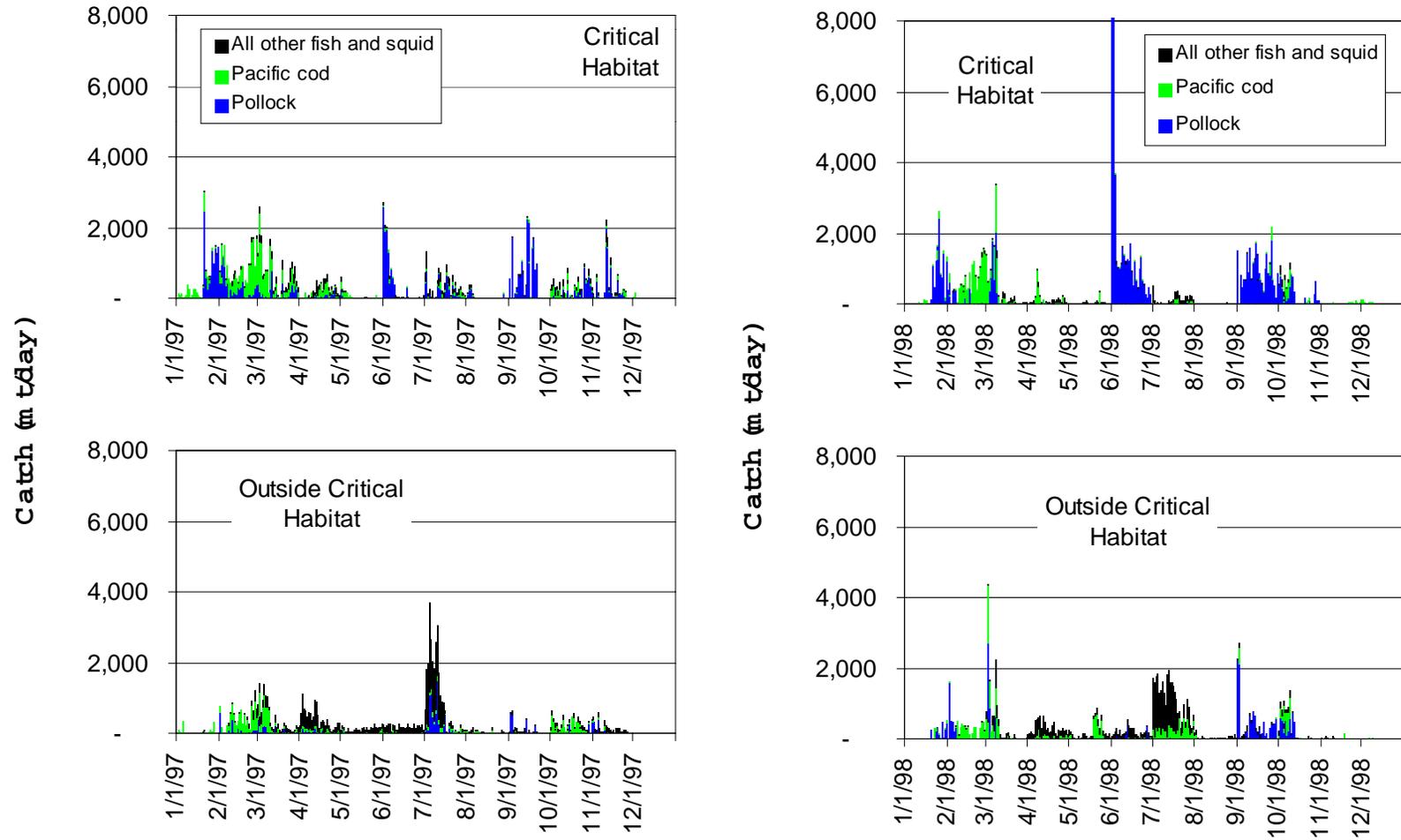
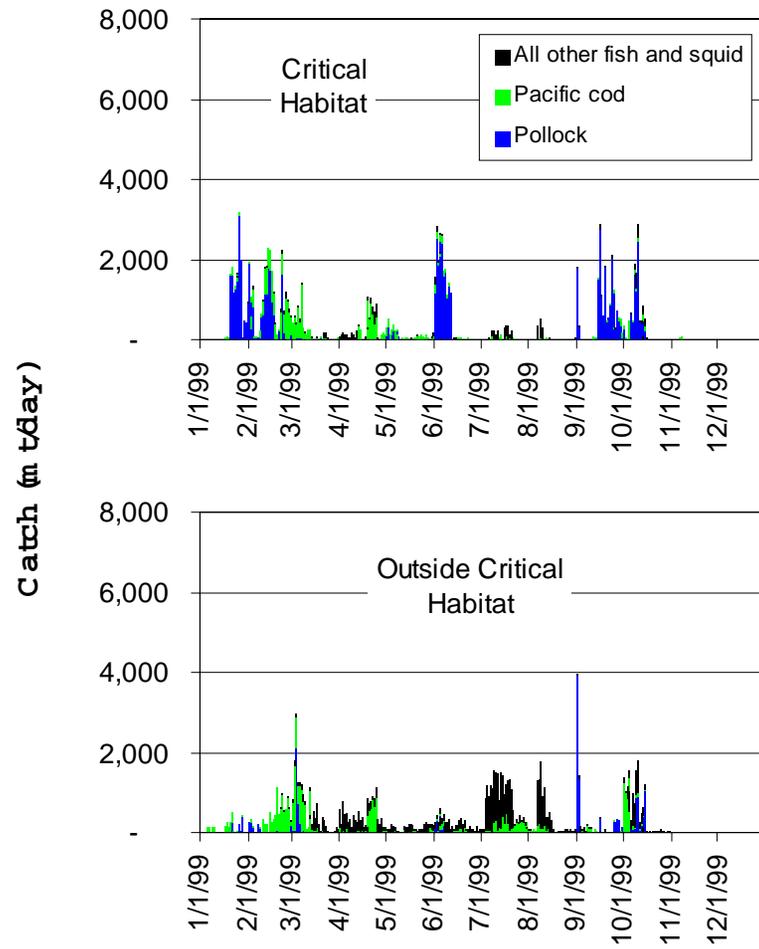


Figure 6.15b. GOA continued.



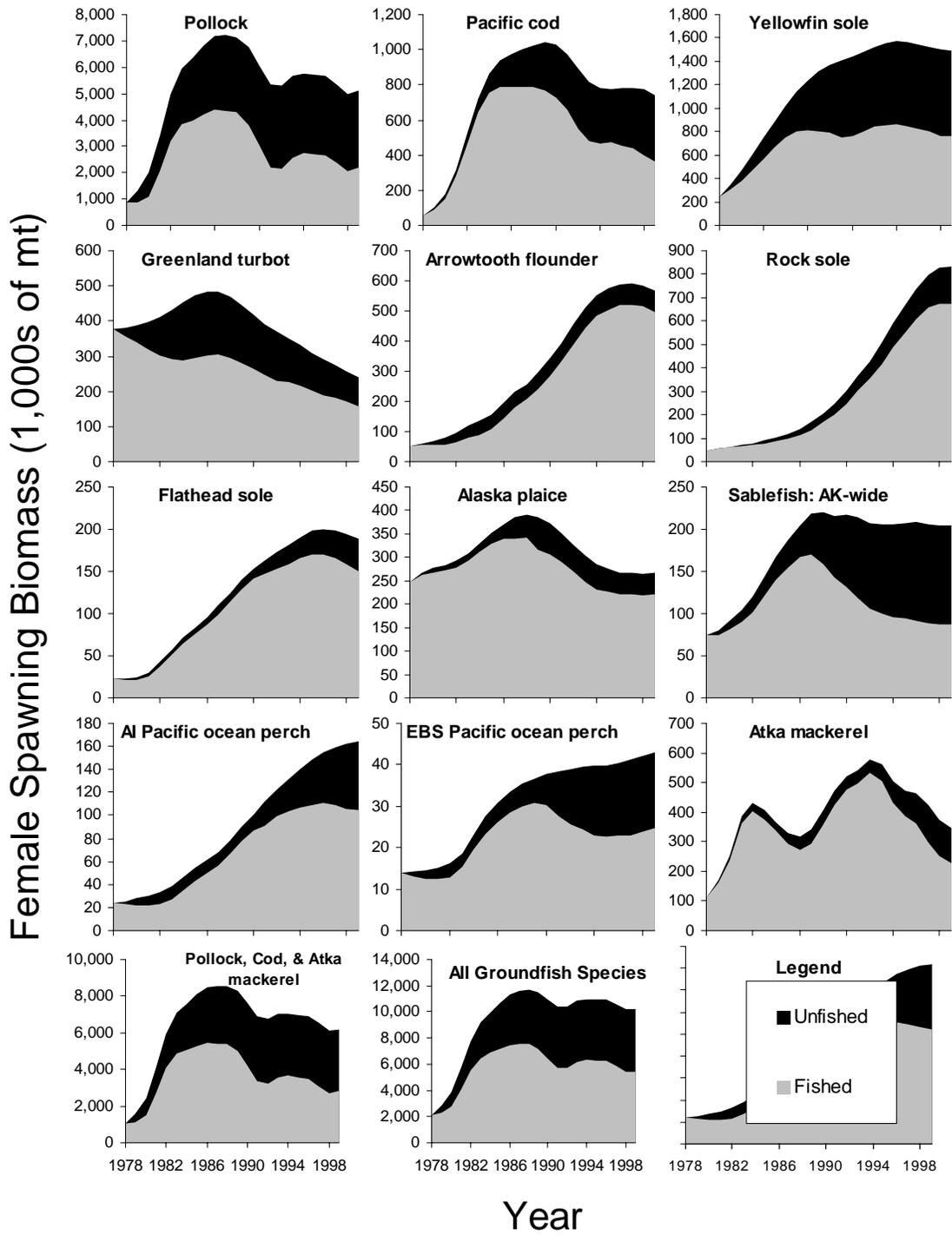


Figure 6.16. Reduction in fish biomass due to cumulative fishing effort on BSAI groundfish.

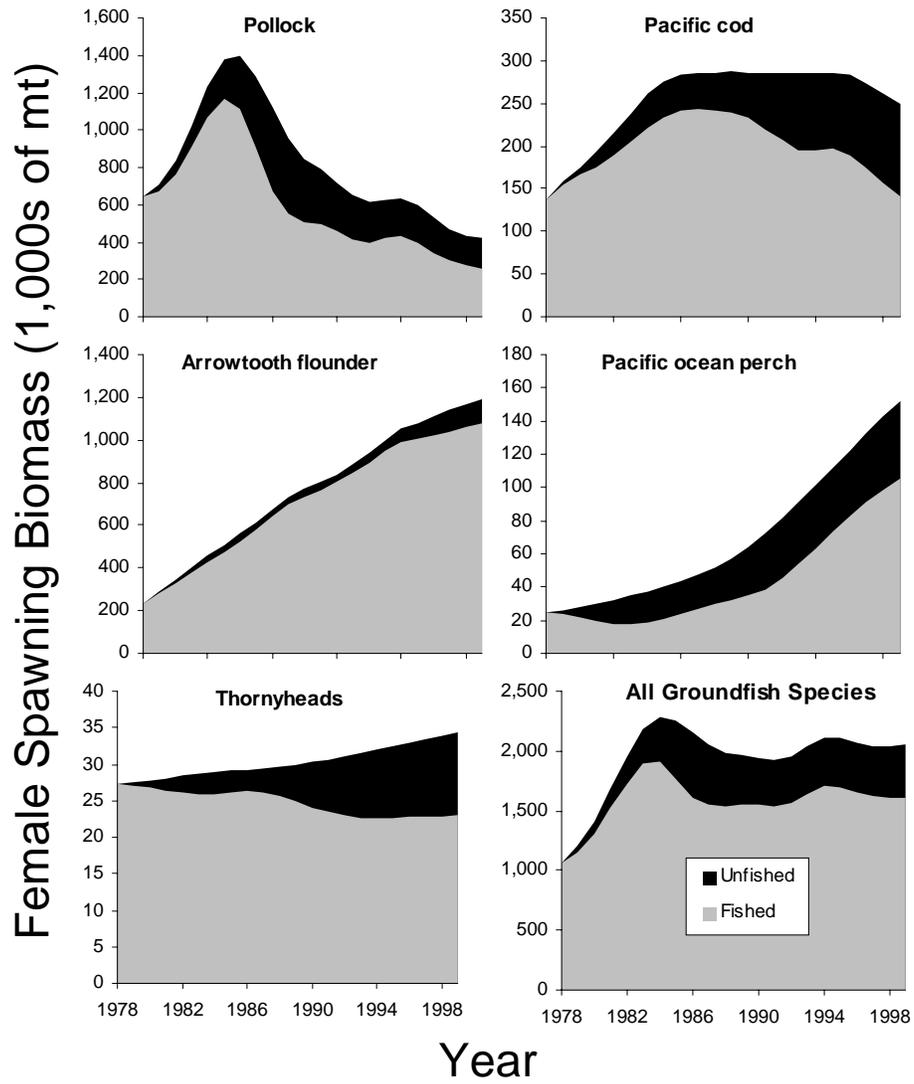


Figure 6.17. Reduction in fish biomass due to cumulative fishing effort on GOA groundfish.

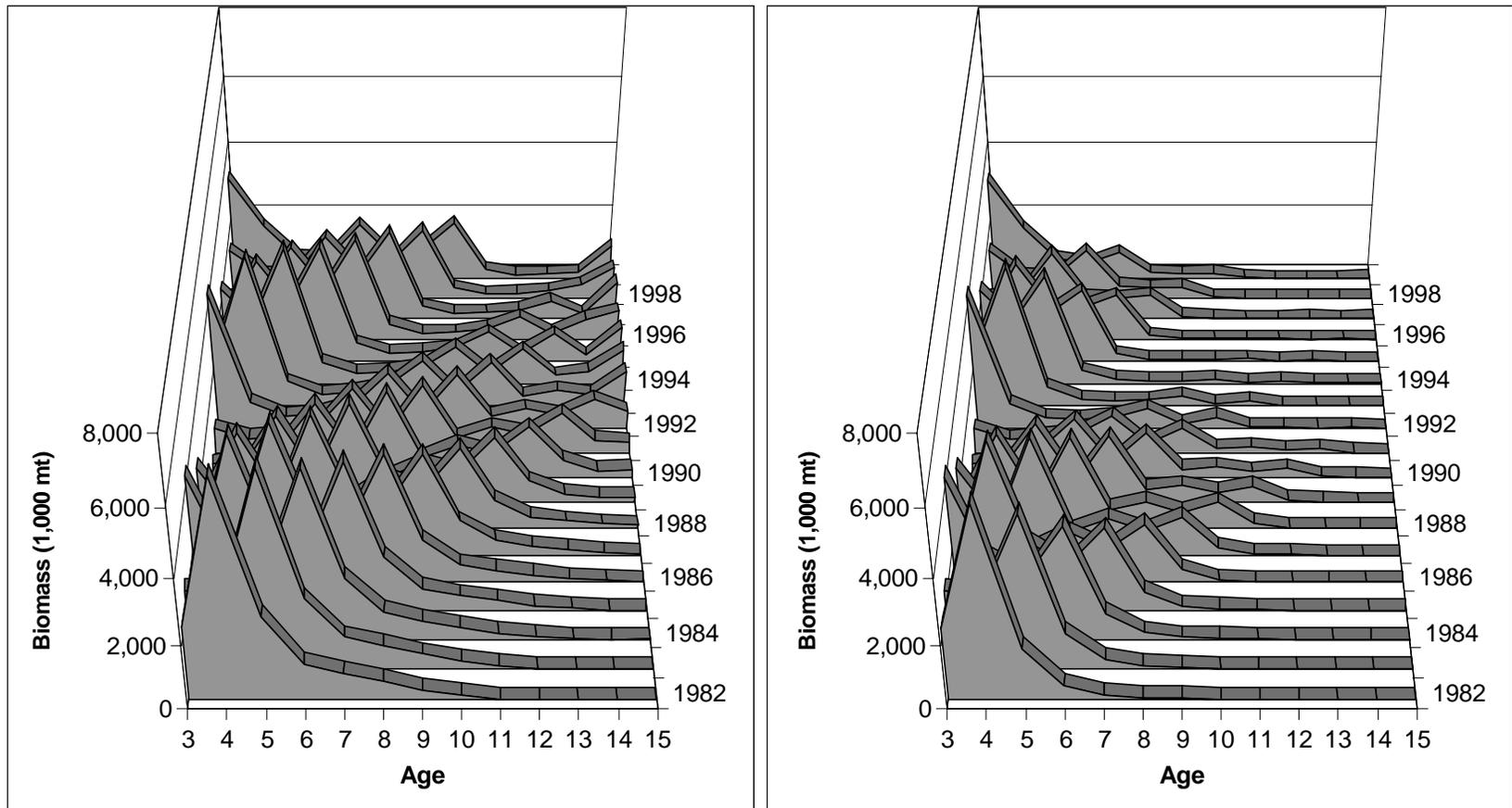


Figure 6.18. Eastern Bering Sea pollock biomass displayed by cohort without fishing (left panel) and with fishing (right panel) applied over the period from 1982 to 1998.

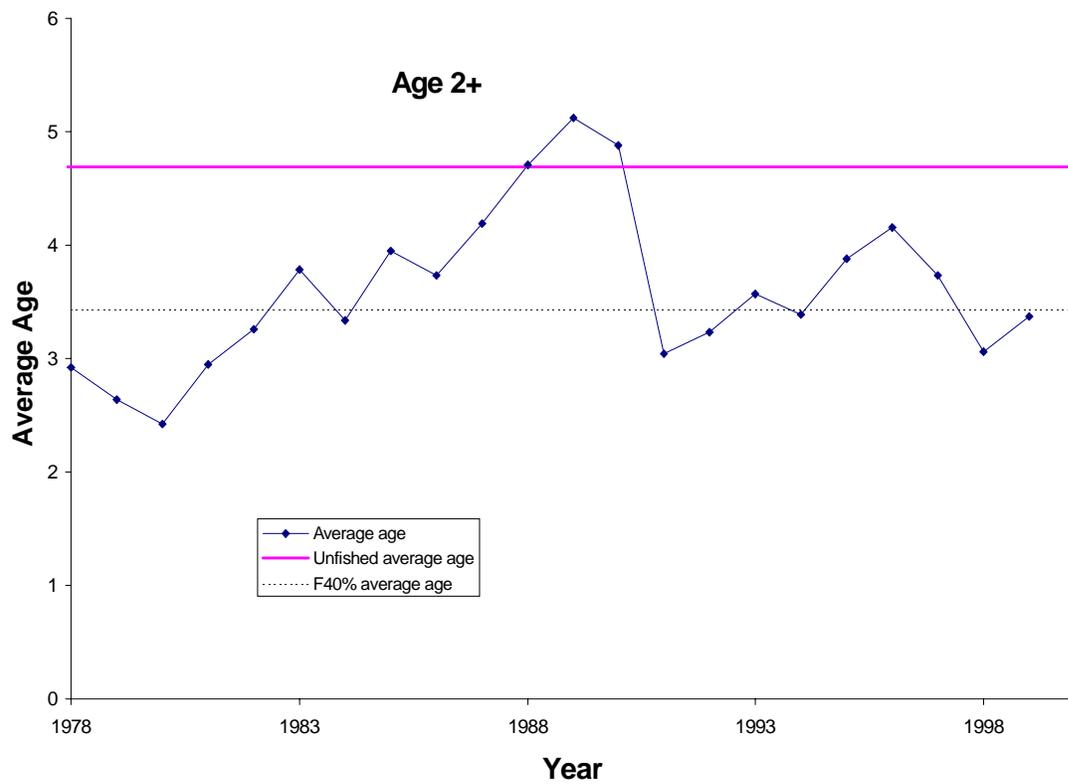


Figure 6.19. Mean age for EBS pollock (1978-1999) from Ianelli et al. (1999) compared to the expected mean age under no fishing and under fishing at a constant F40% harvest rate.

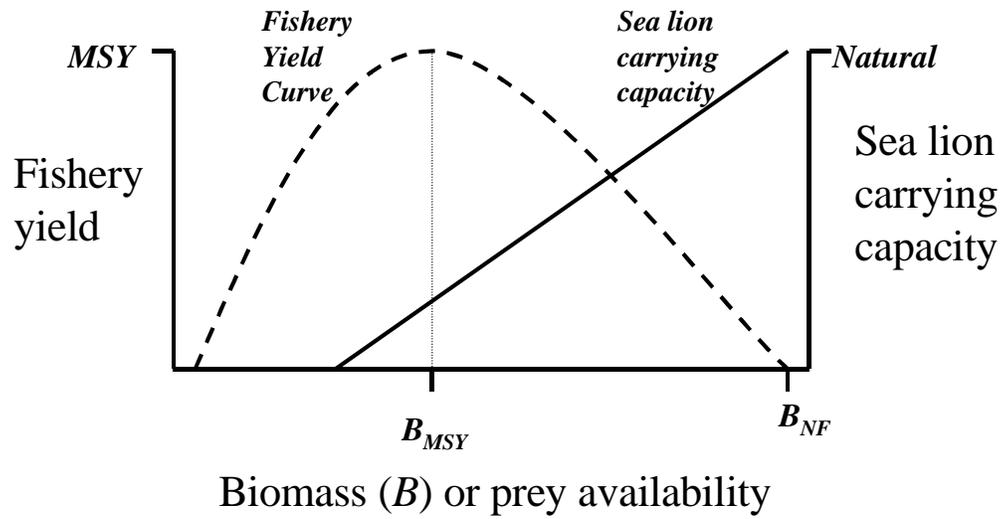


Figure 6.20. Schematic illustration of the relation between 1) the biomass of prey stocks and the yield curve that serves as the basis for the yield-based fishery paradigm, and 2) the simplest approximation of the relation of biomass of the prey stock to the environmental carrying capacity for Steller sea lions.

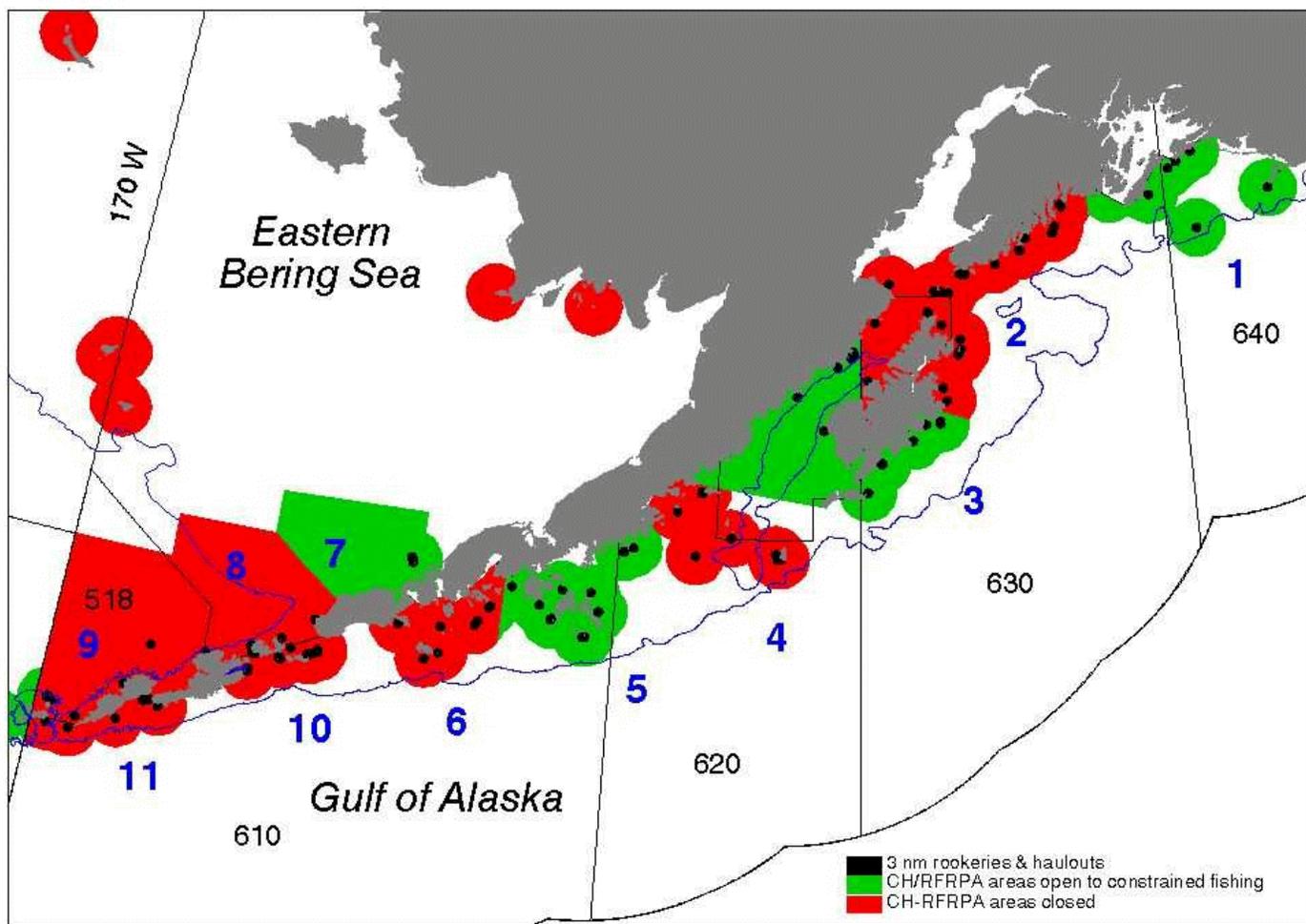


Figure 9.1a. CH-RFRPA areas closed and open to constrained fishing for pollock and Pacific cod fisheries in the Gulf of Alaska. Areas 1-6, 10 and 11 are in the Gulf of Alaska groundfish fishery management region (areas 610-640).

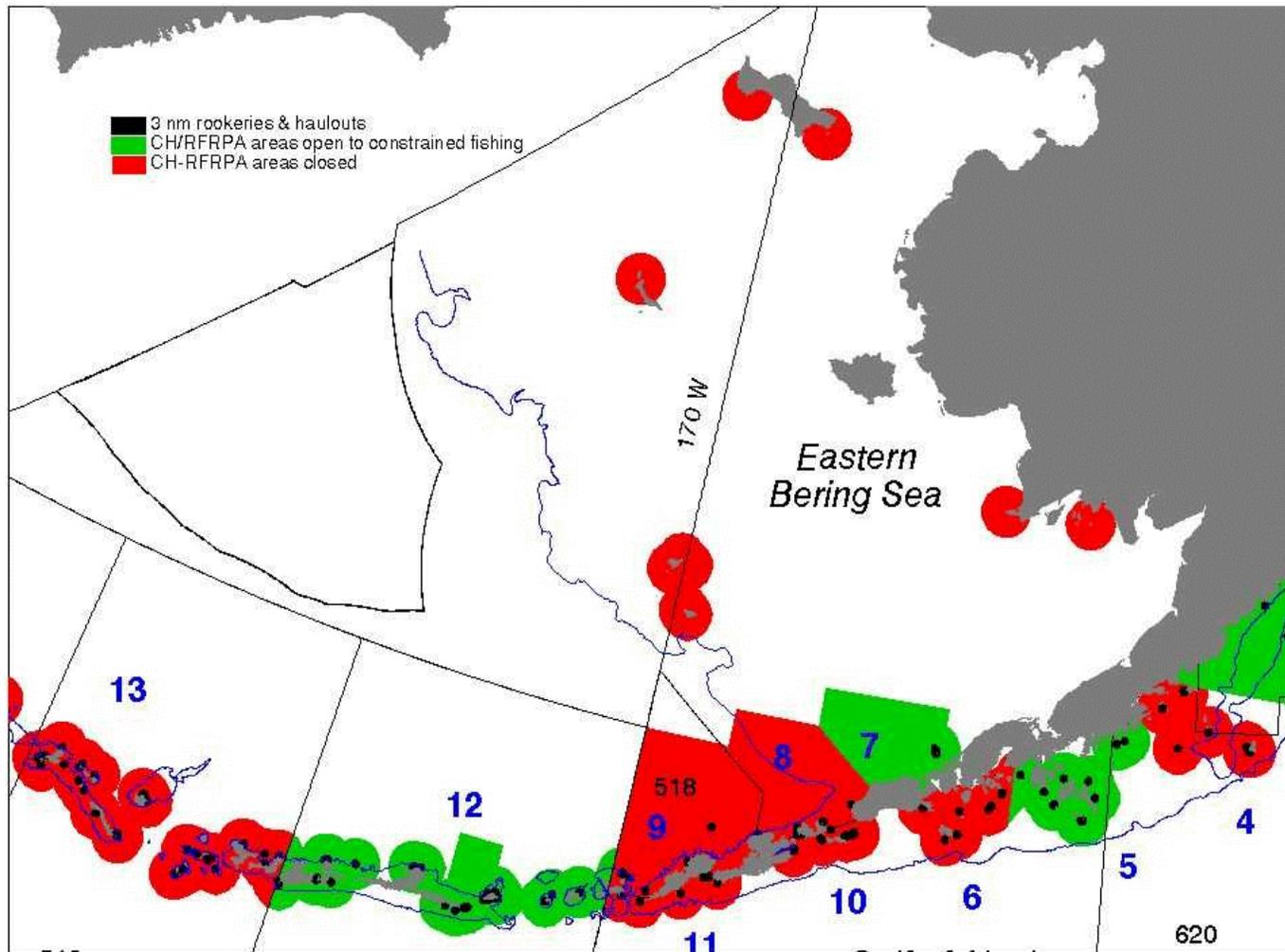


Figure 9.1a. CH-RFRPA areas closed and open to constrained fishing for pollock, Pacific cod, and Atka mackerel fisheries in the eastern Bering Sea. Areas 7-9 are in the eastern Bering Sea groundfish fishery management region.

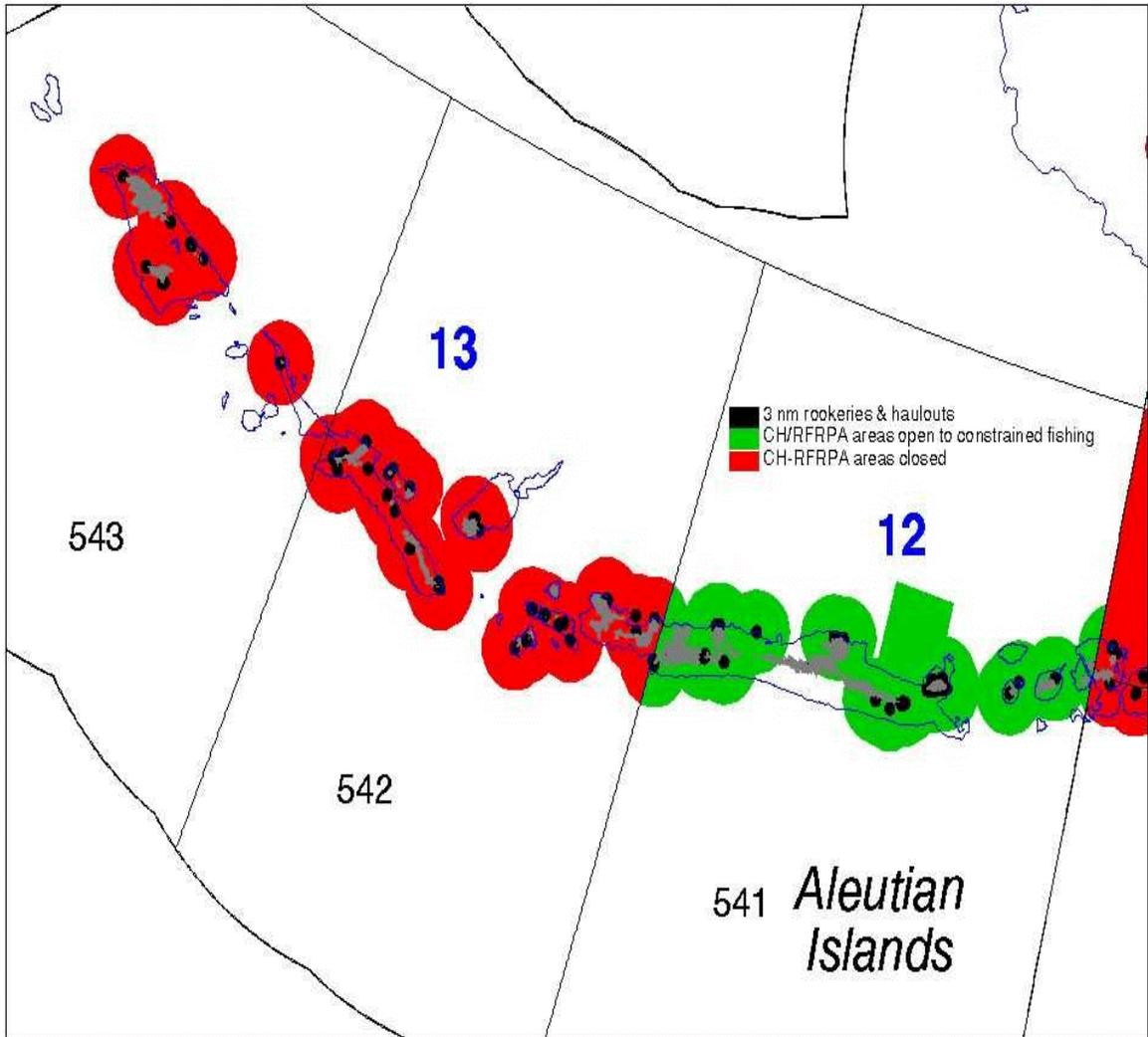


Figure 9.1c. CH-RFRPA areas closed and open to constrained fishing for pollock, Pacific cod, and Atka mackerel fisheries in the Aleutian Islands. Areas 12 and 13 are in the Aleutian Islands groundfish fishery management region (areas 541-543).